OVERSTREET

Report of a comparative test between an automatically controlled heating system and a hand controlled heating system

Architectural Engineering

B. S.

1910

REPORT OF A COMPARATIVE TEST BETWEEN AN AUTOMATICALLY CONTROLLED HEATING SYSTEM AND A HAND CONTROLLED HEATING SYSTEM

BY

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THESIS

FOR THE

DEGREE OF BACHELOR OF SCIENCE

IN

ARCHITECTURAL ENGINEERING

COLLEGE OF ENGINEERING

UNIVERSITY OF ILLINOIS

1910

UNIVERSITY OF ILLINOIS

May 27 1910

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

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ENTITLED "Report of a Comparative Test between an Automatic Heating System and a Hand-controlled Heating System"

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

DEGREE OF Bachelor of Science in Architectural Engineering.

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CONTENTS

LOCATION AND DESCRIPTION OF BUILDINGS

REPORT OF TESTS

REPORT OF TESTS

THE PROCEDURE OF TESTS

RESULTS OF TESTS

LOCATIONS AND DESCRIPTION OF BUILDINGS.

GENERAL LOCATION OF BUILDINGS.

The two buildings tested are located on the Campus of the University of Illinois in a comparatively isolated place. Parallel and north of each building at a distance of about fifty feet is located the Power Plant and Mechanical Engineering Laboratories. Since these buildings are only one story in height and the buildings tested are four stories, the influence on the exposure is small. The only condition which would influence the exposure to any great extent is the protection that one of the buildings tested would offer the other from prevailing East and West winds, but at the time these tests were made, there were no such winds; therefore the buildings may be considered equally exposed.

The shape and size of the buildings can be seen from the floor plans and elevations which are shown on pages 34 to 38.

PHYSICS BUILDING

In this building, which has just recently been completed, every effort was made to secure a structure which would be modern in all its parts. It consists of the following floors:-
The basement where several storage rooms are located, but otherwise used for piping mains from which branches lead to the upper

floors, the first floor, second floor and third floor which are devoted to lecture rooms, recitation rooms, offices, laboratories, etc.; and an attic floor containing a museum, storage, and photographers rooms. In the attic, the roof, which is composed of cinder concrete slabs covered with slate, forms the ceiling in some of the rooms, while in other rooms the ceiling is of plaster hung or furred. All outside walls are built of brick trimmed with Bedford Stone. The bearing partitions are built of brick, all others are of 4 inch hollow tile. The outside walls are furred with 2 inch split tile giving air space between the bricks and plaster, which not only serves as a protection from dampness, but increases the insulating properties of the wall and should be taken into account when figuring for transmission of heat. The stone work on outside walls is merely a 4 inch veneer and since the thickness of walls are somewhat greater on account of the projection of the stone; its conductivity for heat may be considered same as that of main wall on which the stone is located. The fitting of window frames to the brick wall is first class construction, therefore there is not much loss of heat by leakage. All the windows contain glass of single thickness. The thickness of the various outside walls on each floor is as follows:-

Basement floor-------------- 25 inches

First floor----------------- 21 "

Second floor---------------- 17 "

Third floor------------------17 inches

Attic floor------------------13 "

Roof slab including slate---- 6 "

Ceiling height on each floor is 14 feet in clear.

The average thickness of these walls not considering that of the basement, may be taken as 17 inches.

About 10 feet from the main building is located a separate building, containing the tempering room, fan room and a large shop room, sizes of which are given in table number five page sixty. Since the shop is heated by the same heating system as the main building the construction of it should be mentioned, which is the same as that of the main building except the roof which is flat and covered by a composition of tar and gravel.

HEATING SYSTEM.

As already stated the scheme of heating is one of the most modern and is as follows:- All heat is supplied to class rooms, halls, and corridors by means of direct radiation, most of the radiators being of the two column type, several four column; all of which range from 32 inches in height to 38 inches in height. The direct radiation is designed to take care of heat loss due to exposed walls, exposed glass, and leakage. It is designed to keep the inside air at 70 degrees F. when the outside air is at a temperature of-10 degrees F.

The large and small lecture rooms are provided with enough direct radiation to give a temperature of 60 degrees F. in-10 degrees F. weather, the other 10 degrees is supplied by the ventilation system for which the air is heated to 85 degrees F.

The skylights are surrounded by 1 1/4 inch pipe radiator coils.

The particular system of circulation for heating is the two pipe Vacuum Automatic System, installed by the Illinois Engineering Company of Chicago with the Powers Regulating Companie's automatic regulation, and a general description of this system is as follows:- A medium pressure steam main carrying 15 pounds is brought in from a tunnel. From this point a six inch main branchessupplying steam to the blower coils under 15 pounds pressure. In the fan room there is a reducing valve which reduces the steam to desired pressure; and then it is supplied to the coils. Above the 6 inch main, an 8 inch header is extended and from this two 5 inch valved mains are taken off to supply steam for direct radiation. Each branch is provided with a reducing pressure valve. These mains are extended to supply all radiation as shown on heating plan.

A by-pass around the reducing valves is provided, so if it ever becomes necessary, the system can be run under high pressure.

The Seminary room, the First and Second floors, Private

offices and the South East Corner laboratory on Second floor are provided with separate steam mains which in turn are provided with reducing valve, by-pass and pop-valves.

The water of condensation is returned by separate return pipe connected to a vacuum pump located in basement. On each radiator is an automatic return valve at the return end and at the other end, a diaphragm valve, is provided operated by compressed air to regulate the entering steam. From the pump all condensation is returned to Power House.

All steam is supplied from the University power plant which is located about 300 feet away. All steam supplies and return mains enter the building from a tunnel. All mains and returns are provided with valves so that they may be segregated in case of accident.

Fresh air is supplied to class rooms, laboratories, etc., at a temperature of 70 degrees F. through registers placed near the ceiling; the amount admitted to each class room being adjusted so that each pupil will be provided with 30 cubic feet of air per minute. Vent registers from the class rooms, laboratories etc., are placed near the floor and the flues to which they are connected are carried to horizontal mains in attic which are connected to ventilators on the roof. The fresh air is positively supplied by means of a fan and the foul air is removed by the natural draft effect of the vent flues plus the pressure set up in the class rooms.

Fresh air for the ventilating system is taken from large

openings in the wall located about 10 feet above the ground, this opening is covered only by wire netting which I might say here is a probable defect in the system, the air not being filtered or washed. But since the air is comparatively pure, more than that of the city it may not be such a great defect. The tempering coils in tempering room are made up of 476 square feet of Vento cast iron radiators, and 632.3 square feet of radiation made up of wrought iron piping, through which the air is drawn and is tempered to 60 degrees F. On each set of coils is a diaphram valve opened and closed by a thermostat located in the room. In the small fan the reheating coils consists of 554.1 square feet of heating surface and in the large fan there is 693.5 square feet of heating surface. The small fan supplies air to small and large lecture rooms at a temperature of 85 degrees F. while the air of large fan supplying recitation rooms, etc. is heated to 70 degrees F. the temperature being regulated by a thermostat in the duct.

Before going any farther, it might be well to describe an Automatic Regulating Device which is as follows:-

There are several satisfactory and practical systems of automatic regulation. Compressed air is used as a motive force in nearly all of them. The air may be compressed by an electric or steam pump, by compressor, belted or geared to the other machinery or by a small hydraulic pump. All of these devices are in common use and all may be provided with automatic gover-

ners which throw the pumps out of service when the air pressure drops.

The standard system of automatic regulation operates as follows:- From a central air tank small pipes lead to each room and then to each radiator or damper to be controlled. In each of these rooms is located a small valve called a thermostat, which opens automatically and permits the air to pass by and close the radiator valve or hot air damper, as the case may be. When the temperature in the room rises above the desired point, the valves and dampers are provided with springs or counter weights so when compressed air is admitted to them the heat is always turned on, this is provided so that, should the regulation be inoperative there would be merely the possibility of an excess temperature. These systems of automatic regulation are mere devices to shut off the heat when same is not needed, and therein lies a money saving virtue.

The particular system that is used in the Physics Building is the Powers System,which is operated by compressed air. A 30 gallon reservoir is located in the cold air intake so that the moisture in the air may be taken out at this point by the cooling process. From the tank riser mains, to various thermostats, are connected. The piping is run so that it is well drained, and drip pockets located where necessary.

FANS

A 150 inch steel plate three quarter housed fan with

bottom horizontal discharge is installed for large buildings in general. For small & large rooms a 120 inch steel plate three quarter housed with top horizontal discharge is used. The 150 inch fan is capable of delivering constantly 30000 cubic feet of air per minute. The 120 inch fan is capable of delivering constantly 15000 cubic feet of air per minute while operating at not more than 175 revelutions per minute.

In order that there may be no unnecessary loss of heat from the building at night when the ventilating system is not in use, there are shut-off dampers placed in the risers to the ventilators on the roof. The dampers are opened or closed at the will of the operator by means of a pneumatic switch placed at a convenient point on the first floor.

ENGINEERING BUILDING.

This building is located within 60 feet to the West of Physics building, and has about the same exposure as that of the Physics building excepting in case of West winds, when the Engineering building receives the direct exposure and protects the West side of Physics building, which can be clearly seen from plan on page 34 . The building has four floors and a sub-basement. On first, second, third and fourth floor are located offices, lecture rooms, recitation rooms, drawing rooms, laboratories and toilets for the various departments of engineering. Sub-basement is used only for installation of steam mains

etc. From the plans and elevation the reader can get a better description of the building than is possible to convey in words.

In about one half of the rooms on the upper floor, the ceiling is formed by the roof itself. While the other part has plastered ceiling exposed to attic which might be considered warm due to the overhead steam mains. The roof has a great deal of skylight area in it, supplying light to the hall, drafting room, and a few offices.

The building is not of fireproof construction as the Physics building. The roof is made up of rafters, purlins, sheathing and slate. All floors are constructed of wooden joist to which is attached the plastered ceiling and wooden floors.

The walls of the second, third and fourth floors are 25 inches thick, while that of the basement and first floor including measurments over the stone is 32 inches thick. In considering the thickness for heating calculation we might use the wall as 25 inches instead of 32 inches because the stone is a better conductor for heat than the solid brick wall. All outside walls are plastered on wooden lathes furred out from the brick. This of course, leaves a dead air space and not only prevents the dampness going through but makes the wall a better insulater for heat.

The construction of brick openings, window frames, etc., may come under the same type of constructing as that of the

Physics building.

The Heating system was designed by the Architect, G. W. Bullard, and installed by Maltby and Wallace Company of Champaign, Illinois. The original system has under-gone a considerable number of changes until the present one has been developed, which is merely a direct system of heating from both cast iron, and wrought iron pipe, radiators. The system of steam piping used is what is known as the "Mill's Overhead System." The steam, which is delivered into the sub-basement of the building at about 40 pounds pressure, is passed through an 8 inch Davis reducing pressure valve and the pressure reduced to one to five pounds, as the external temperature demands. The steam, after passing the reducing valve, is carried through an 8 inch main to the attic of the building, where it divides into three equal branches 4 1/2 inches in diameter, and is thus distributed to the three wings of the building. The overhead mains in the attic are covered with asbestos fire proof covering. From the mains run the smaller mains to the sides of the building and then drop to the sub-basement in straight runs. From these risers single connections are made to each of the radiators. Liberal provision is made for expansion of all pipes and connections.

In the original system most of the radiators were installed as indirect and were placed under the windows and in a recess left for them in the brickwork. The air supply came through openings in a cast iron plate, which forms the lintel of

the window below, passing up to the radiator through a space left for it in the wall. Provision was made to induce a flow of air through the radiators by ventilating shafts distributed throughout the building. These shafts were of two kinds; one heated by pipe coils extending from the top to the bottom floor, and the other was arranged to be connected to an exhaust fan placed in the basement of the building.

As the heating system is at present, all the indirect radiators have been made direct by taking out the registers and closing the openings to the outside air. The radiators were left in the recesses of the walls. Due to these recesses at present the circulation of air around the radiating surface is not as good as it would be if the radiator was placed out in the room. The ventilating system was never adequate and no exhaust fans were ever installed. The changing of the indirect radiators cut off all air supply and the only ventilation now obtained is due to the natural draft in the vent flues. All valves for supplying steam to radiators are hand controlled, there being no automatic regulation at all in building. When the rooms get too warm, windows are raised and an immense amount of heat is lost. In many cases probably the radiator is shut off. When this is done there will be no losses. But such a system as this will always produce varying temperatures in a room which is very disagreeable to occupants.

REPORT OF TESTS

PURPOSE OF TESTS.

In undertaking this investigation the main purpose was to test the two systems of heating in such a way that such data may be secured to make a comparison of each system, as to cost, manipulation, constant temperature produced, effiency etc. In test number 5 the purpose was to find the amount of heat that may be radiated only by the piping system.

In order to determine the above mentioned data, the following had to be made in the test:-

Weight of condensed steam.

Temperature of the condensed steam.

Temperature of Rooms.

Temperature of Outside air.

Steam pressure in mains.

Quality of Steam.

Vacuum readings.

In order to determine the final results other data necessary is as follows:-

Exposure.

Amount of radiation in building including type, kind, height, sections, number of columns, location etc.

Amount of exposed glass in building.

Amount of exposed wall in building

Amount of exposed roof in building

Amount of exposed skylight in building

Amount of exposed floor in building.

Thickness of walls and material of which it is made, kind of glass etc.

PREPARATION FOR TEST

WEIGHING THE CONDENSATION OF STEAM:-

To weigh the condensation from the returns; the first requirement was to connect to return main a pipe from which ran two branches to a convenient place where the water could empty into tanks that were placed on scales. At the turn of each branch pipe was provided a tee instead of an elbow. In one end of this tee was inserted a brass temperature well, deep enough so an accurate temperature of the water flowing through the pipe could be had. This well was filled with oil in which a thermometer was placed that read over 250° F. Both return pipes of each system were fixed in this way. In the Engineering building the water was returned by three traps, while in the Physics building the water was returned by a vacuum pump.

In order to weigh the condensation from both buildings 4 pair of scales and 4 tanks were necessary; two of each at the return main of each building. The reason for using the two pair of scales for each return main was on account of weighing and emptying the water of each tank. While one tank was

being weighed, and weight recorded, emptied etc., the other tank would be filling. In order to weigh the steam that was liable to flow through the return or the water evaporating into steam again due from release of pressure, cold water was put in each tank about one fifth full. This would condense the steam and in this way no shortage of weight was allowed.

TEMPERATURE OF BUILDINGS.

In order to get the temperature of the buildings thermometers were placed over different parts of each.

In the Engineering building three themometers were put on each floor, well distributed over it in different rooms so that a good average temperature of the building could be had. On all four floors themometers were placed in this way. In placing them in rooms, particular care was exercised in order to get the themometers located so as to give a good average temperature of the room.

In the Physics building a themometer was in every room on each thermostat which was located on an inside wall not exposed to outside air. Since this building was automatically regulated it was not necessary to read all the themometers but read only four, distributed over each floor so as to give a fair average temperature which is a little fairer than that of Engineering building where only three were used on each floor. All themometers were tested by comparing a standard with each.

It was found that none of them varied more than a half degree, some reading low and others reading high.

OUTSIDE TEMPERATURES

The outside temperatures were recorded by a Bristol's Recording Themometer in Mechanical Engineering laboratory located near the buildings being tested. In this way a record of the outside temperatures may be had for any time of the day. This themometer was located about midway of the south wall of Mechanical laboratory where a good, fair temperature of the outside air could be measured.

PRESSURE IN STEAM MAINS

In order to determine the temperature of the entering steam, the pressure of same must be observed at different times during the test. In the Physics building a steam gauge was already provided on the reading board. In the Engineering building a tap in the steam main was made and a steam gauge attached. Both gauges were calibrated and found to correspond with the Standard. Both were placed in a conspicious place so they could be read with as little trouble as possible.

VACUUM READING

The only vacuum reading necessary was in the Physics

building. No provision had to be made for a gauge. On the reading board near the pressure gauge was located one. Considering this reading of very little importance no calibration was made. Since the system in the Engineering building is a gravity system no vacuum reading was required.

MOISTURE IN STEAM

The moisture in steam was observed in order to get the exact amount of heat in the steam. The amount of moisture was determined by the use of a Carpenter's separating calorimeter attached to the pipe to which the pressure gauge was attached. A mistake was made here by the use of a Carpenter's separating calorimeter instead of a Throttling calorimeter. The steam being rather dry at times no reading could possibly be made with the one used because it should be used only when the steam is very moist. To bring back to the readers mind the principle by which the separating calorimeter works; it might be well to explain its working principal which is as follows:- The instrument is virtually a steam separator and mechanically separates the moisture from the sample of steam. The water thus separated collects in a reservoir provided with gauge glass and graduated scale, while the dry steam passes through an orifice to the atmosphere. The weight of dry steam per unit of time is indicated on the gauge, calculated by Napier's rule, or may be determined by condensing and weighing. The latter method being

used in these tests. The accuracy of the moisture determination is greatly affected by the difficulty of obtaining true samples of steam containing large percentages of moisture.

In order to get a good sample of steam the standard sampling tube, adopted by American Society of Mechanical Engineers, was used.

RADIATING SURFACE IN BUILDINGS

At first a method for getting the square feet of radiating surface in building was by the use of the building working plans, but checking a few measured radiators with those on plans of building. They did not check very close, so it was finally decided to go through each building get a record of the actual amount of radiation in every room and coridor.

In the Physics building the type, height, number of columns and number of sections were recorded. Since the cast iron radiators generally have the correct amount of radiation listed in catalogues. This was used in determining the amount of radiating surface.

In the Engineering building there were two kinds of radiators, cast iron, and wrought iron made of one inch piping screwed in a common header at each end. The same method was used as that of the Physics building except, instead of using the catalogue rating for the wrought iron radiators, the surface was actually measured, which was found to be less than the rated

surface. It is generally understood that wrought iron pipe radiators are generally over rated while those of cast iron are not so much.

For future reference I have inserted the tables showing the type, height, etc., of radiators in the various rooms on each floor of each building.

In getting the square feet of radiating surface due to exposed and covered piping it is rather indeterminate, and would require a great deal of time and painstaking to measure it. Mr. Morrow, Superintendent of Buildings, has given an amount of pipe surface in the Engineering building measure by some of his men, but since some of the piping is covered and part not covered and not knowing the amount of each, we have gained but very little information that would be of any value.

In the Physics building the piping is all covered with an asbestos covering. As to the amount of this piping it has never been measured.

A very interesting test, number 5, was made on the piping system of the Physics building with all radiators off, results of which will be shown later. In this way an equivelant amount of radiating surface was figured and used in final results.

The amount of direct radiation in each building is as follows:-

Engineering Building.

Radiators-----------------9441 square feet

Piping--------------------1558 " "

Total----------10999

Physics Building

Radiators-----------------9648 square feet.

From these figures can be compared the radiating surface of one building with that of others. The Physics building contains only 207 square feet more than the Engineering building. If we should consider the bare piping that is exposed in the Engineering building with that of the Physics building it would be safe to assume the radiation in each building about the same.

WALL SURFACE EXPOSED

The amount of wall exposed was calculated by room measurement, length being clear distance between walls. With the length given and the height, the total exposed wall including glass was calculated. The wall area minus the glass area is equal to the net exposed wall. The total net wall of each building including roof area is as follows:-

Engineering building------29045 square feet

Physics building----------31585 " "

GLASS SURFACE

The glass surface is measured by width and height of brick opening. The amount of glass in each building including skylight is as follows:-

Engineering building-----10676 square feet

Physics building--------- 9386 " "

CUBIC CONTENTS

Cubic contents were figured as clear space in room, as recorded in tables on pages 56-63 . To get the total cubic contents of each building all room contents were added and are as follows:-

Engineering building-----778110 cubic feet

Physics building---------849554 " "

RUNNING OF TESTS

In order to get fair comparative results of the two kinds of heating systems they were run at the same time and under the same conditions. There were three tests attempted in order to make the comparison, but the first one of seven hours run, Jan. 18, 1910, was spoiled by carelessness. The steam main of the central wing of the Engineering building filled up by condensation and was not noticed until several hours after the test began. The cause of this trouble was due to one of

the return valves not being opened to drain pipe. The results of the test on Engineering building were not worked up, but, that of the Physics building was, and recorded in final tables, page 32 In this test the coils of the fan were on from 11 A. M. to 12 A. M.

TEST NO. I.

The second test, a comparative one, proved to be very satisfactory in every way, and was made Jan. 19, 1910, day following first test, the average temperature of outside air being 42.3° F. At the beginning the outside air was 25° F. and at end of test it reached 48° F. This test was run for eight hours, the longest test made of the series. The sun was shinning most of the day and a strong wind from the north was in action most of the time.

TEST NO. II.

This, a comparative test, was made February 12, 1910. The duration of this test was seven hours and it was quite successful. Everything ran very smoothly all during the time. At the beginning the outside air was at a temperature of 17° F. and ended with a temperature of 20° F. average for the day being 20° F. This test proved to be the most important because the outside air was at its lowest. At a low temperature of the outside air the effiency of the two systems will compare closer

than it will at a higher temperature. This is probably due to overheating of rooms, and escape of heat due to raised windows which would be practiced in the Engineering building.

All the above tests No. 1 and 2 were made for comparison of the two heating systems. In order that the conditions might be made as near equal as possible, the fan coils of Physics building were not used at all during these tests.

TEST NO. III.

This test was made on the Physics building February 18, 1910 with fan coils in operation. It was run for purpose of finding the extra amount of power required to use the fan coils. This test was made under very favorable conditions, everything ran very nicely during the seven hours time. The temperature of outside air at beginning of test being 7° F. and at the end 15° F. averaging for day 17° F.; the temperature being very satisfactory. It was probably one of the coldest days of the season.

TEST NO. V.

Test No. 5 was a two hour test made on the piping system alone. It was made at night during a time when the building was not in use. All radiator diaphragm valves were closed by turning the themostat regulating hand back to 50°. This, of course, cut the steam off until the temperature in room reached 50° F. which

was produced after closing the steam off of radiators for two hours. This test proved to be very interesting. The temperature in building at beginning of test was about 70 degrees F. and at end about 50 degrees F. The gradual droppingof temperature in the building had some effect on the amount of condensations from deginning to end, but not so much as anyone might imagine. The outside temperature averaged 10 degrees F. The purpose of running this test was to obtain some idea of the amount of heat radiated from the piping of a heating system.

THE PROCEDURE OF TESTS

WEIGHING OF WATER.

All necessary aparatus was put in place as explained under the head of preparation for tests. A log sheet was prepared on which was recorded the time, weight of condensed steam temperature of same, steam pressure, and vacuum reading. The readings were taken at the filling of each tank which varied, the length of periods, depending on the amount of condensations flowing from radiators in the building. Care and acuracy were practiced during all tests. In the tables of data the readings are recorded as they were during the test. It required two men working very steady to weigh the condensations and record the weights etc.

TEMPERATURES AND OBSERVATIONS IN BUILDINGS

The temperatures of the various rooms in each building were recorded about every hour during the test. It required one man to take these temperatures. During his rounds the radiators were watched to see about what part of radiating surface was on, and whether the windows were open or closed.

PHYSICS BUILDING

In this building no windows were seen open, and at most of the observations it seemed that very little radiating surface was used, especially during the warm day tests. Since there were no windows open and no ventilation in use during the first three tests the results will be used to determine the probable leakage in a building. Most authors claim this leakage to be about one to two changes of air per hour depending on the construction of buildings.

ENGINEERING BUILDING

In the Engineering building it might be estimated that only about one half of radiating surface was on at times due mostly to air bounded which was caused by the air valves not being inworking order. At times the radiators were closed by students. Windows were found open in many instances where the room became excessively heated. In all probability if the system in the

Engineering building had been in good working order so no radiation could have been cut out due to air bounding the results would have shown much more heat used. The reason for making this statement is; had all radiators been in good working order there would have been more radiating surface thereby giving off more heat. Working under ordinary conditions the windows would be opened by students rather than cut the steam off from the radiators thereby losing an excessive amount of heat.

MOISTURE IN STEAM

As stated before a Carpenter's separating calorimeter was used on all tests to determine the moisture in the steam. An attempt to take readings about every hour was made, but the attempt was unsuccessful. In some tests the readings were made while in others they were not, due probably to the steam being so dry at times that this kind of calorimeter was not sufficiently accurate to determine the per cent moisture. As has already been stated a Carpenter's separating calorimeter can be used only when steam is excessively wet. In this case a thottling calorimeter should have been used.

OUTSIDE TEMPERATURES

At the beginning of the tests the recording thermometer in the Mechanical Engineering laboratory was started. At the end

of the day the cards were taken out and dated. This method of getting the temperature is probably the best and requires less trouble. It was observed now and then during the test to see if the clock was running.

RESULTS OF TESTS

A table has been prepared showing in a reduced form the data taken during the tests and alsothe results. This table will be used to calculate the following results, most of which has been recorded in the table so a comparison can be made very conveniently.For the reader who is probably interested in the amount of water used at different times of the day curves have been platted showing the variation.

HORSE POWER REQUIRED

The horse power required per hour during each test is shown in table of results. This horse power is calculated by dividing the equivelant condensations per hour by 34 1/2. The required amount per hour per degree difference of temperature of inside and outside air would be the horse power per hour divided by the difference in temperature during each test. These results vary somewhat, more than might be expected, the cause is due probably to the conditions of the atmosphere, temperatures etc.

CHANGE OF AIR IN BUILDING

The changes of air in a building is an important factor to consider. A great deal of heat is required to heat a large quanity of air. The changes are always caused by leakage through the material, crevices and cracks in walls and windows, opening of doors, windows etc. In the table of results can be noticed the excessive amount of heat required for Engineering building compared to that required for Physics building. It certainly cannot be caused by the difference in exposure and size of building but was caused by the leakage and the opening of windows etc., in order to keep the temperature comfortable. This produced a number more changes of air than was necessary.

Take test No. 1 for example--The heat loss through the walls of Engineering Building allowing 1.2 B.t.u. loss through glass per hour per degree difference in temperature of outside and inside air, is equal to 537500 B.t.u. per hour. The amount of heat actually used was 3314618 B.t.u. a difference of 2777118 B.t.u. which was used to heat air that produced the changes. To calculate the number of changes that took place would be as follows:

The amount of heat required to warm the air of one change equals $\frac{30.9^{\circ} \times 778110}{55}$ = 4371563 B.t.u. (30.9 equals difference between inside and outside air. 778110 equals cubic contents of building. 55 equals the number of cubic feet of air 1 B.t.u. will raise 1° F. per hour) 2777118 B.t.u. divided by 436500 B.t.u. equals 6.3 = changes of air that must have taken

place.

The heat loss per hour in Physics building through the walls and glass equals 1.2 x 29.2 x 17283 = 605608 B.t.u. The amount used according to test equal to 1045370 B.t.u. A difference of 439762 B.t.u. The amount of heat required to produce one change of air equals $\frac{849550 \times 29.2}{55}$ = 451016 B.t.u. 437156 B.t.u. divided by 451016. = .974 almost 1 change. A window in the Physics building was never seen open during any of these tests, since this was the case the amount of leakage through window frames, walls etc., can be determined. By various authorities this leakage is generally assumed to be from 1 to 2 changes depending on construction of building. Good construction is allowed 1 change which compares very closely with that calculated in test No. 1 and 2 of Physics building

STEAM CONDENSED PER SQUARE FOOT HEATING SURFACE

The values shown in the table represents the actual amount of steam condensed per square foot of radiation but that proportion condensed by considering all the heating surface in building as radiating heat. The heating surface shown does not include any piping, therefore it should be consdered that part of the steam is condensed by the piping. As to the amount, it is indeterminate. But as a comparison of test it would be approximately correct, as shown before, to consdier the amount of radiation including piping etc., as about equal to each other. The heat given off

by one square foot of radiating surface as shown in table is calculated on the above basis.

AMOUNT OF RADIATING SURFACE IN USE DURING THE TEST.

The amount cannot be accurately shown because there is no data showing the amount of radiation on during the test, which could not be determined on account of the automatic regulation in Physics building and due to air bounding of radiators in Engineering building. The only method for calculating approx. the amount of radiation on during the test, is by the use of the amount of heat transmitted by one square foot of surface per hour per degree difference in temperature of steam in radiator and the temperature in room. This value has been determined by tests. Table on page shows the results of a number of tests made by the Experiment Station of the University of Illinois on cast iron radiators some of which were made on the radiators in the Engineering building. The average result of these tests is 1.58 B.t.u., the value which will be used in determining the amount of equivelent radiation in each building. This equals to the total B.t.u. consumed per hour divided by 1.58 times the difference in temperature in building and the temperature of steam in radiator. This result should be called the equivelant of cast iron radiation because the piping radiates a great deal of the heat. In the table, results show that the equivelent radiation in the Engineering building is more than the number of square

feet actually in the building, this is due to the excessive amount of wrought iron pipe radiators which radiate as much as 2 B.t.u. per hour per difference in temperature at times instead of 1.58 B.t.u., the value used in figuring.

AMOUNT OF COAL AND COST REQUIRED FOR OPERATION OF THE HEATING SYSTEM

The number of B.t.u. required per hour per degree difference in temperature of outside air and inside air varies in each building in each test. In order to get the amount of coal it is necessary to reduce the B.t.u. used per hour, to pounds of coal, this is calculated by allowing for the coal a colorific value of 11300 B.t.u. per pound and allowing 55 per cent of it utalized in the form of steam. Therefore the number of pounds of coal required per hour per degree difference of outside and inside air equals to the number of B.t.u. consumed by the building per hour per degree difference in outside and inside temperature divided by 11300 x 55 per cent.

In test No. 1 and 2 of the Engineering building the number of pounds of coal required equals 17.25 pounds and 11.43 pounds respectively. These values cannot possibly correspond with each other very closely under ordinary conditions because of the chances of losing heat through opened windows etc.. are so great. But in the Physics building when this does not occur then, when only the direct radiation is on, the amount of coal

utilized per hour should be about the same. In the tests No. 1 and 2 this amount was 5.76 pounds and 5.56 pounds per hour which corresponds very closely.

According to test No. 3, where the fan coils were in operation all the time it requires 11.2 pounds per hour per degree difference outside and inside air.

According to test No. 4 where the fan was on one hour, the amount of coal utilized was 7.75 pounds per hour per degree difference in temperature of inside and outside air. This test was made under ordinary conditions when the fan was run one hour to supply ventilation to the lecture rooms.

Should it ever be necessary to calculate the cost of operating the heating system during a season, the cost of coal, the cost of maintainance, fireing of boiler etc., and the average temperature of outside air during the season must be known.

TABLE OF RESULTS

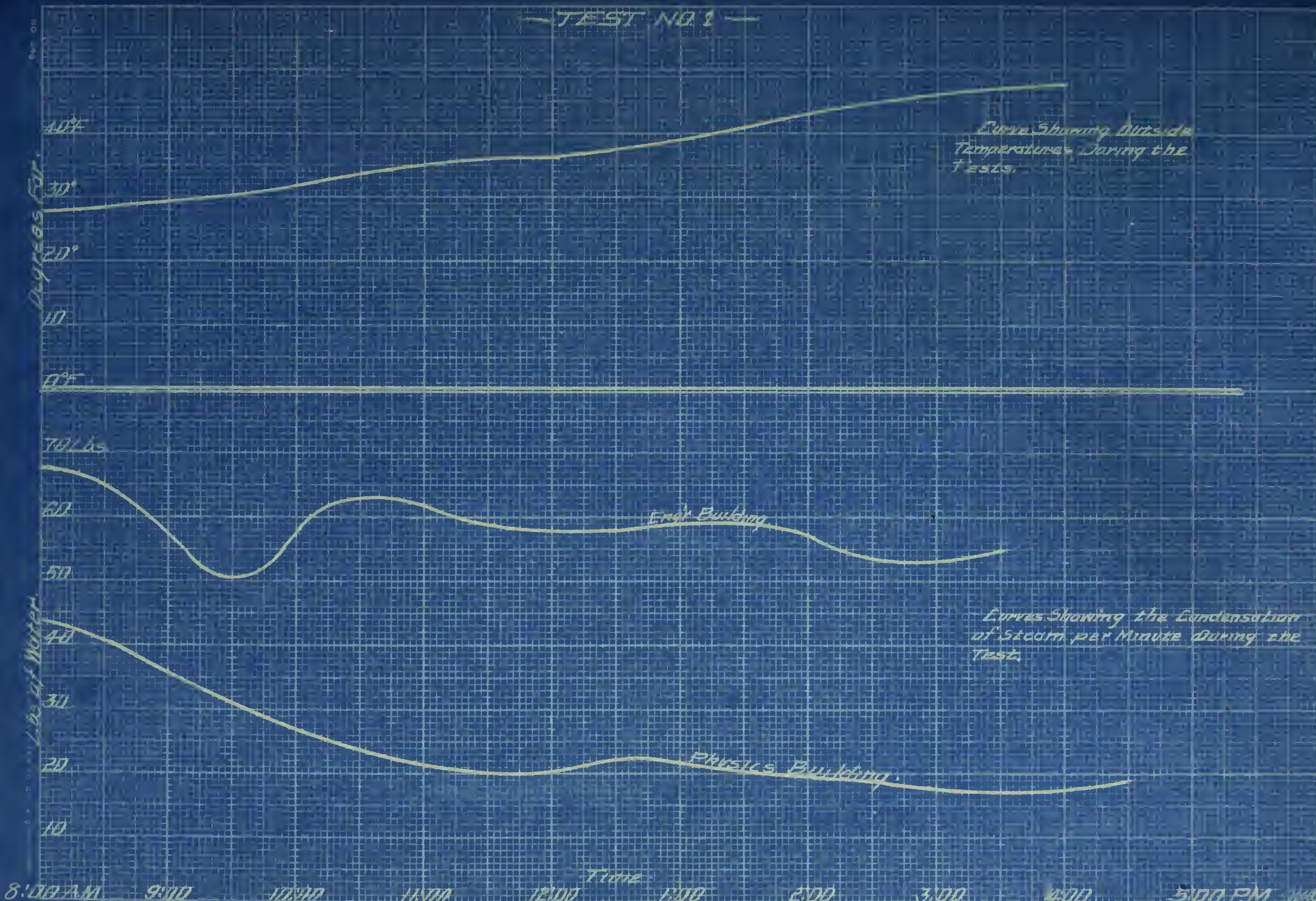
NUMBER OF TEST	NO. 1		NO. 2		NO. 3.	NO. 4.	NO. 5.
BUILDING	ENG'R	PHYS.	ENG'R	PHYS	PHYS	PHYS	PHYS.
Date of Test	Jan 19/10	Jan. 19/10	Feb. 12/10	Feb 12/10	Feb 18/10	Jan. 18/10	Feb 18/10.
Duration of Test	8 Hrs	8	7	7	7	7	7
Mean Steam Pressure	7.3 Lbs	3	7.8	3	3	3	3
Mean Temp. of Entering Steam - °F	233	221	234.2	221.5	221.5	221.5	221.5.
" " " Building "	73.2	71.5	71.	70	71.4	70.2	60.
" " " Outside Air "	42.3	42.3	20.8	20.8	17.	35.	10.
" " " Return Water "	216	200.7	218.1	192.8	199.3	202.5	175
Moisture in Steam-percent	1.0	1.5	—	1.0	—	—	—
Total Weight of Condensed Steam	27665.0 Lbs	8660	25830	12427	26489	12146.	1360
" " per Hour in Lbs.	3458.0	1082.5	3690.	1785.	3784	1735	680
Total Ht. in 1 Lb of dry Steam - P	1153. Btu	1149.5	1153.3	1149.5	1149.5	1149.5	1149.5
" " " " " Return Water "	185	169.4	186.4	161.5	168.0	171.2	144.5
" " " " " Water "	202.2	190.5	203.4	190.5	190.5	190.5	190.5
Quality of Steam	.99	.98	1.	99	1.	1.	1.
Moisture in Steam	.01	.015	—	.01	—	—	—
Tot. Ht. in 1 lb. of Steam	1143.5	1135.1	1153.3	1139.9	1149.5	1149.5	1149.5
" " " " " Return Water	185.0	169.4	186.0	161.5	168	171.2	144.5
Heat Loss by 1 lb. of Steam.	958.5	965.7	967.3	978.4	981.5	978.3	100.5
Factor of Condensation.	.9925	1.00	1.0017	1.013	1.016	1.013	1.041
Eq'v. Condens'n per hr at & to 212°F	3432.2	1082.5	3696.3	1758.5	3844.6	1757.7	707.9
H.P. Consummed	99.48	31.38	107.14	50.97	111.44	50.95	20.52
" " " 1° Dif. Inside & outside Air.	3.20	1.074	2.14	1.071	2.05	1.447	.41
" " Required for 0. F. Weather.	225.3	75.3	149.8	75.	142.9	101.29	28.7
Tot. Ht. Rad. per Hr. Btu.	3314618	1045370.	3569337	1698405	3714094.	1697450	683400

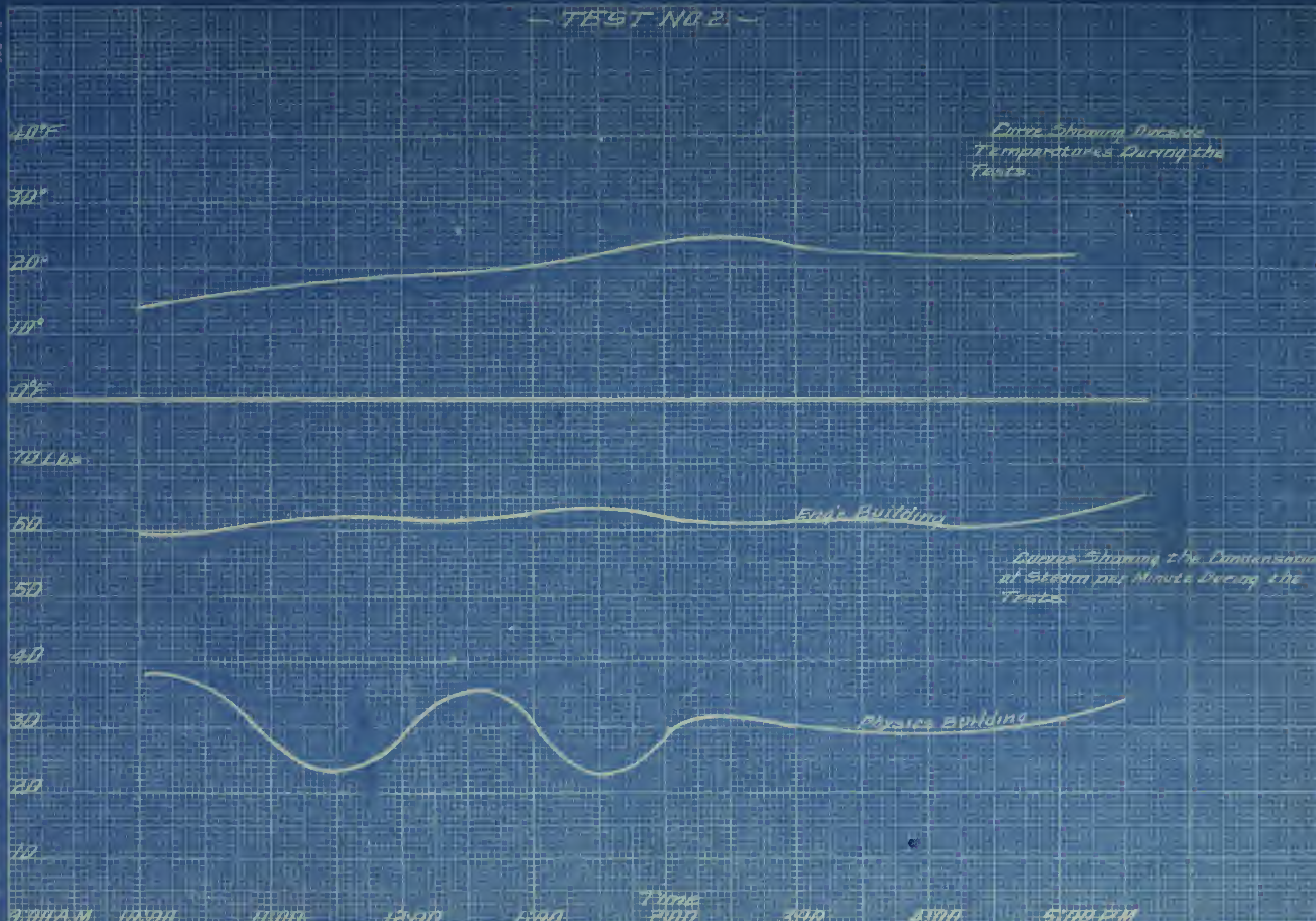
awe

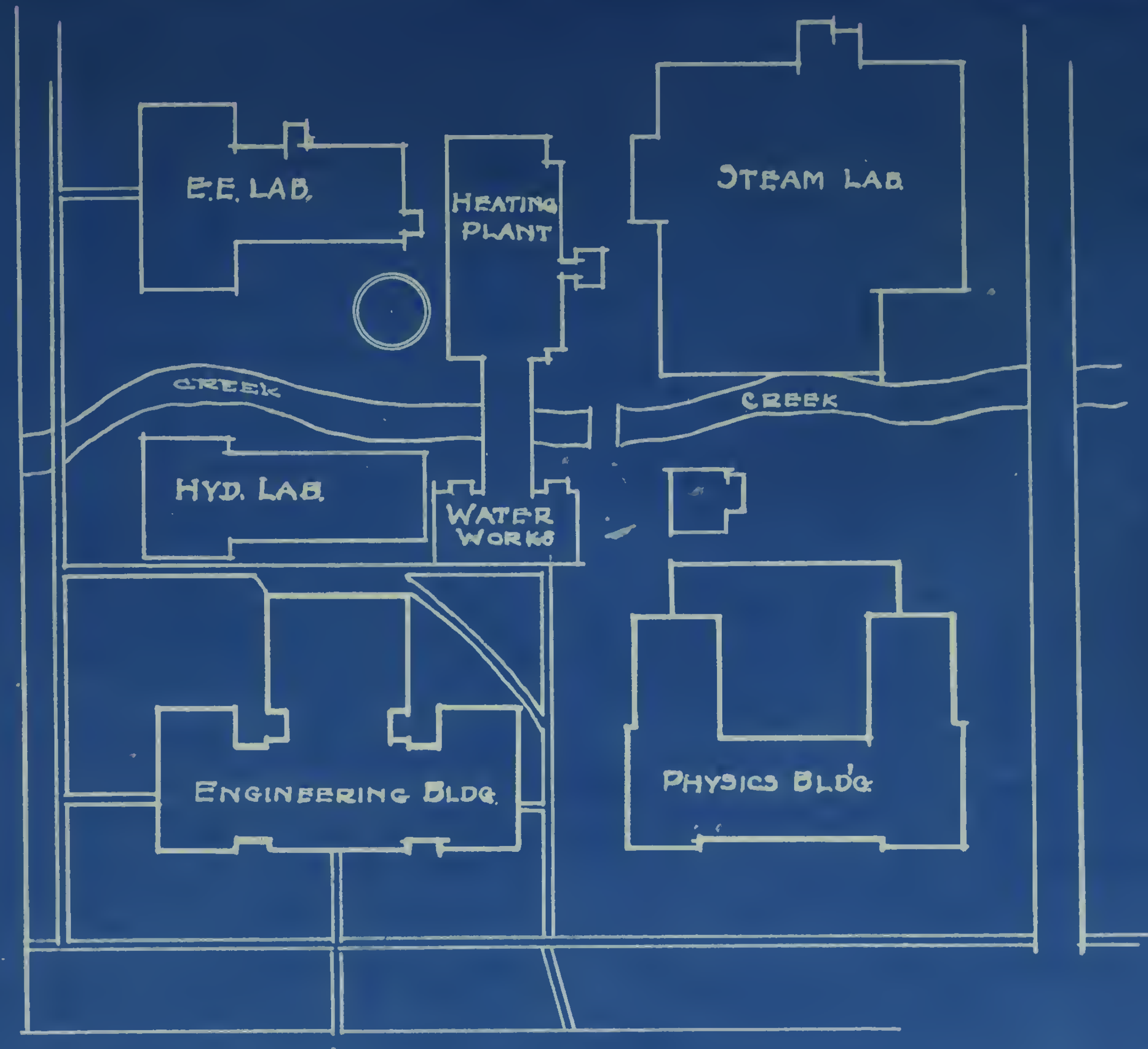
TABLE OF RESULTS CON'T

NUMBER OF TEST	NO. 1.		NO. 2.		NO. 3.	NO. 4.	NO. 5.
BUILDING	ENG'R	PHY'S	ENG'R	PHYS.	PHYS.	PHYS.	PHYS.
Total sq. ft. of direct Rad. Sur.	9441	9648	9441.	9648.	12066	Fan coils off and on.	Equiv. Heat Sur. 2490
Steam cond per Sq. Ft. Ht. Sur/hr	.366	.1124	3919	.185	(See Text.)		
Ht. Trans'd. per Sq. Ft. per Hr. per °dif. T.	2.198	.723	23.2	1.164	"		
Cubic Cont of Building - cu. ft.	778110	849550	778110	849550	849550	849550	849550.
Btu per Cu. ft. per degree Dif. T.	.1377	.0422	.0915	.0406	.0566	—	—
Net Exposed Wall - sq. ft.	29045	31586.	29045	31586	31586	31586	31586
Glass Surface Exposed Sq. ft.	9664	9387	9664	9387	9387	9387	9387
Equiv. Glass Surface	14505	17283	14505	17283	17283	17283	17283
Changes of Air in Building	6.3	.98	4.12	.90	3.08	1.78	
Heat Loss thro Walls & Glass	537500 Btu	605000	873781	1,020000	1128000	728200	
" " by Ventilation	2777118 "	440370	2695556	678405	2586094	969250	
" Req. for 1 Ch. of Air.	436500 "	450000	655000	760000	840000	543600	
Amt. of Eq. C.I. Rad. Sur. in use - sq. ft.	13110	4420	13970	7090			2490
Btu's Req. for Bldg / °Dif inside & Outside Air	107100	35800	71100	34500	68350	48200	13650
Lbs. of Coal required " " "	17.25	5.76	11.43	5.56	11.0	7.75	

mwb

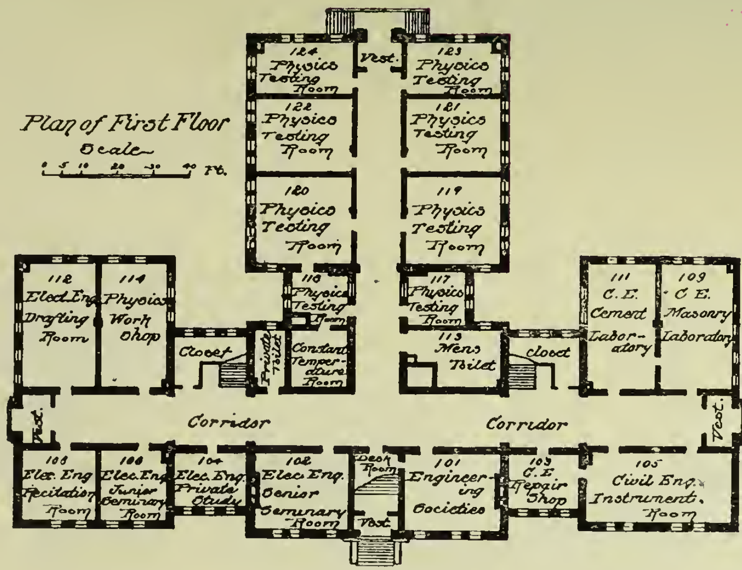

— TEST NO 1 —
Curve Showing Outside Temperatures During the Tests.
Degrees Far.
40°
30°
20°
10
0°F
70 Lbs.
60
50
40
30
20
10
Lbs. of Water
Engr. Building
Physics Building.
Curves Showing the Condensation of Steam per Minute During the Test.
Time
8:00 AM
9:00
10:00
11:00
12:00
1:00
2:00
3:00
4:00
5:00 PM


— TEST NO. 2. —
Curve Showing Outside Temperatures During the Tests.
40°F
30°
20°
10°
0°F
70 Lbs.
60
50
40
30
20
10
Eng's Building
Curves Showing the Condensation of Steam per Minute During the Tests.
Physics Building
9:00 A.M.
10:00
11:00
12:00
1:00
Time
2:00
3:00
4:00
5:00 P.M.

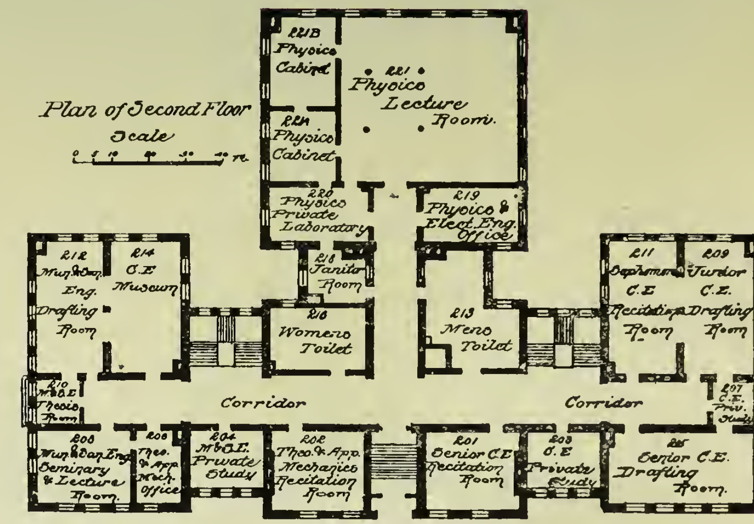


- PLOT SHOWING LOCATION OF BUILDINGS -

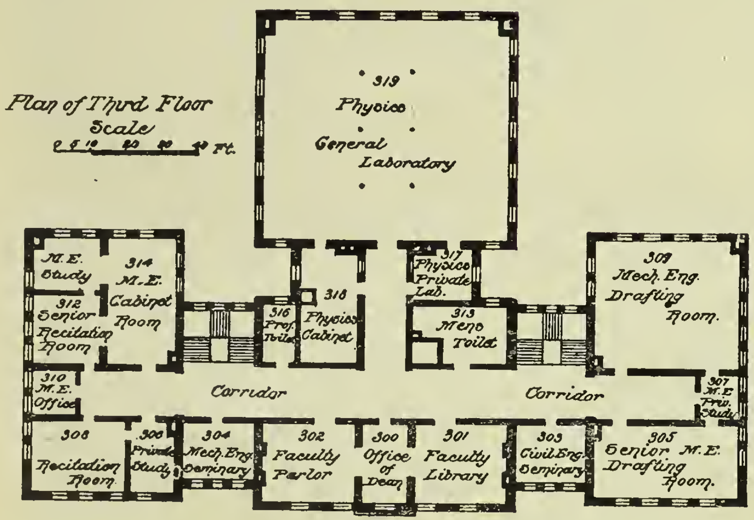
Plan of First Floor
Scale



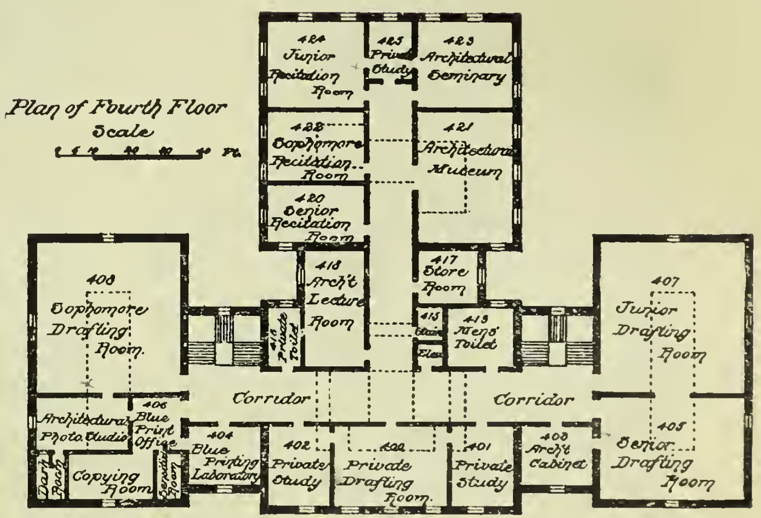
Plan of Second Floor
Scale



Plan of Third Floor
Scale

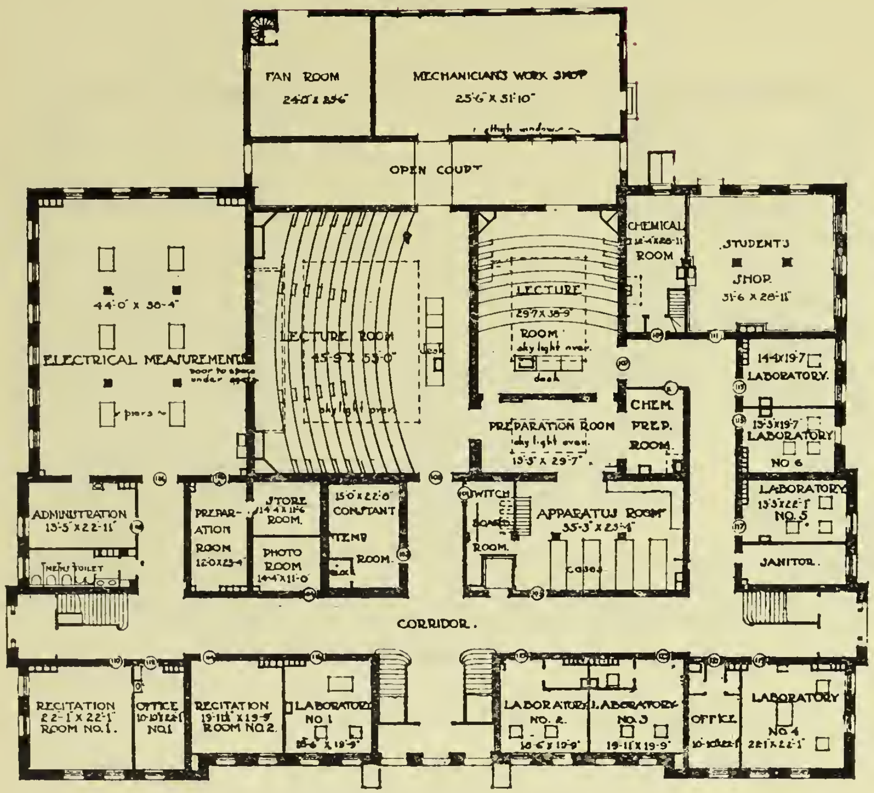


Plan of Fourth Floor
Scale

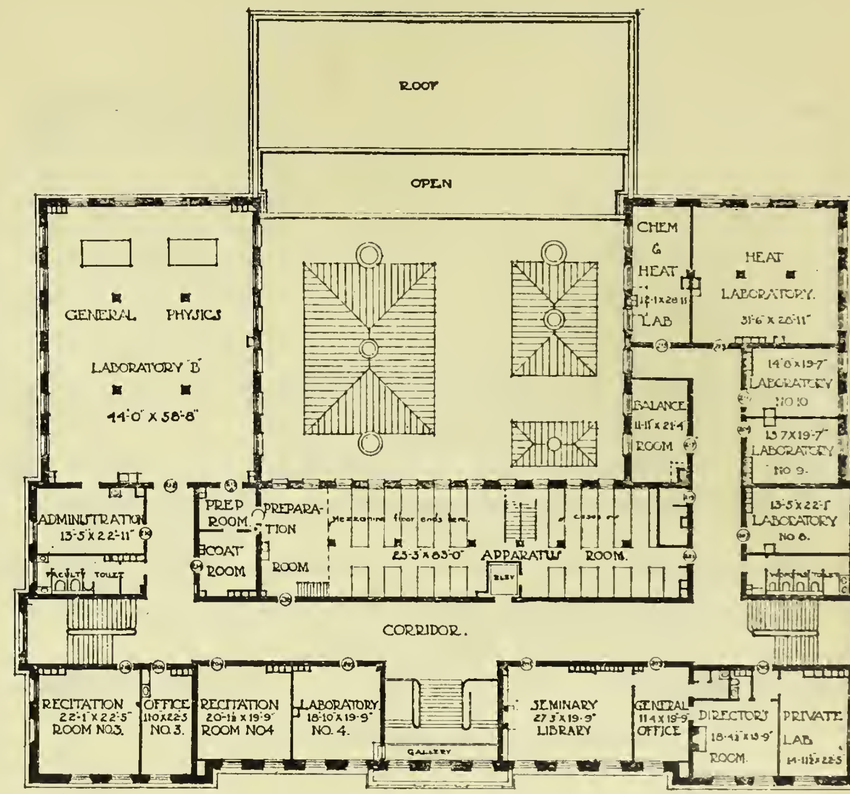


ENGINEERING BUILDING

—ENGINEERING BUILDING—

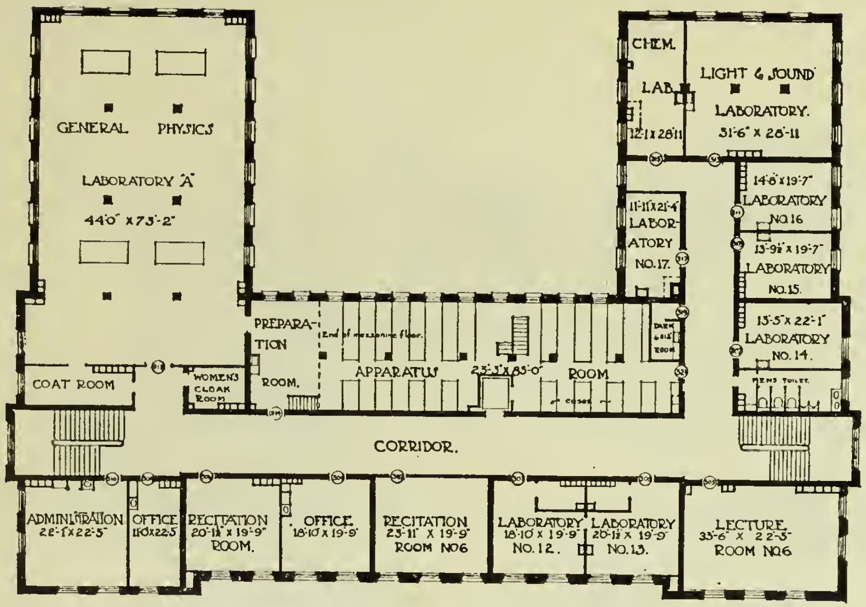


FIRST FLOOR PLAN

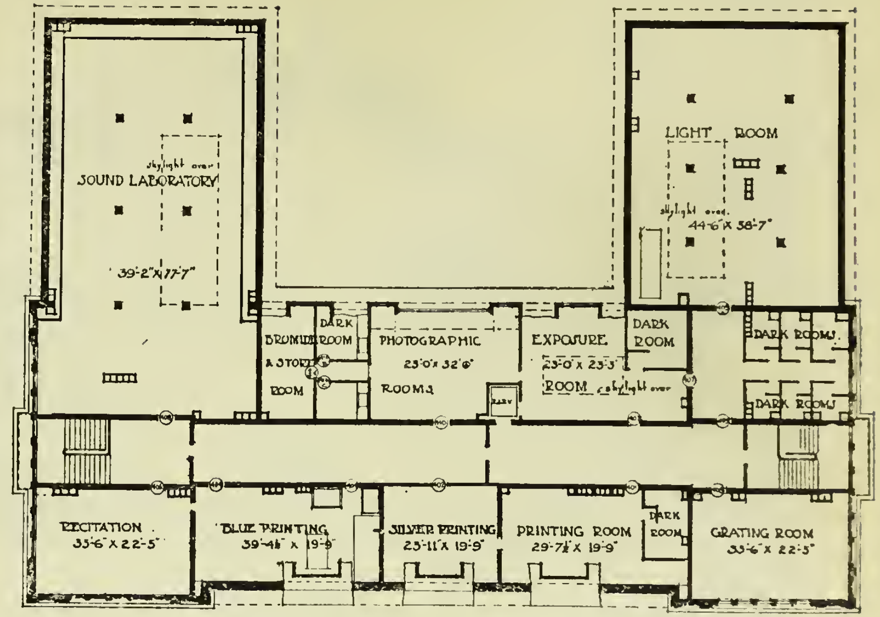


SECOND FLOOR PLAN

PHYSICS BUILDING



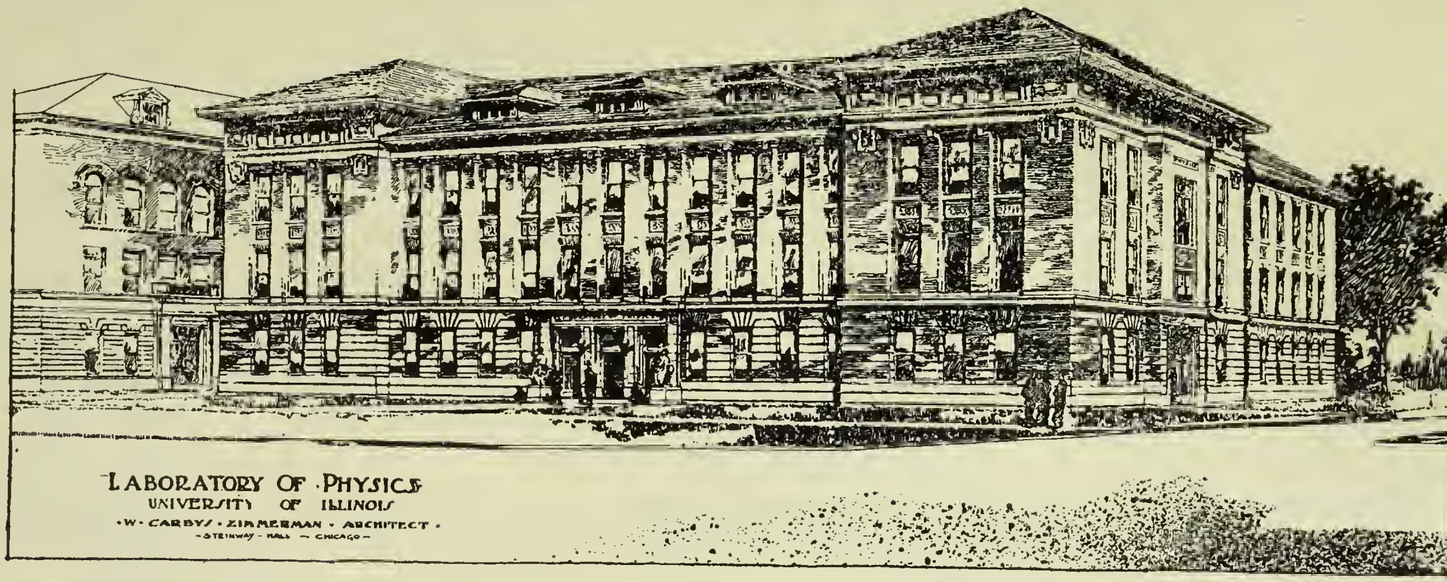
THIRD FLOOR PLAN



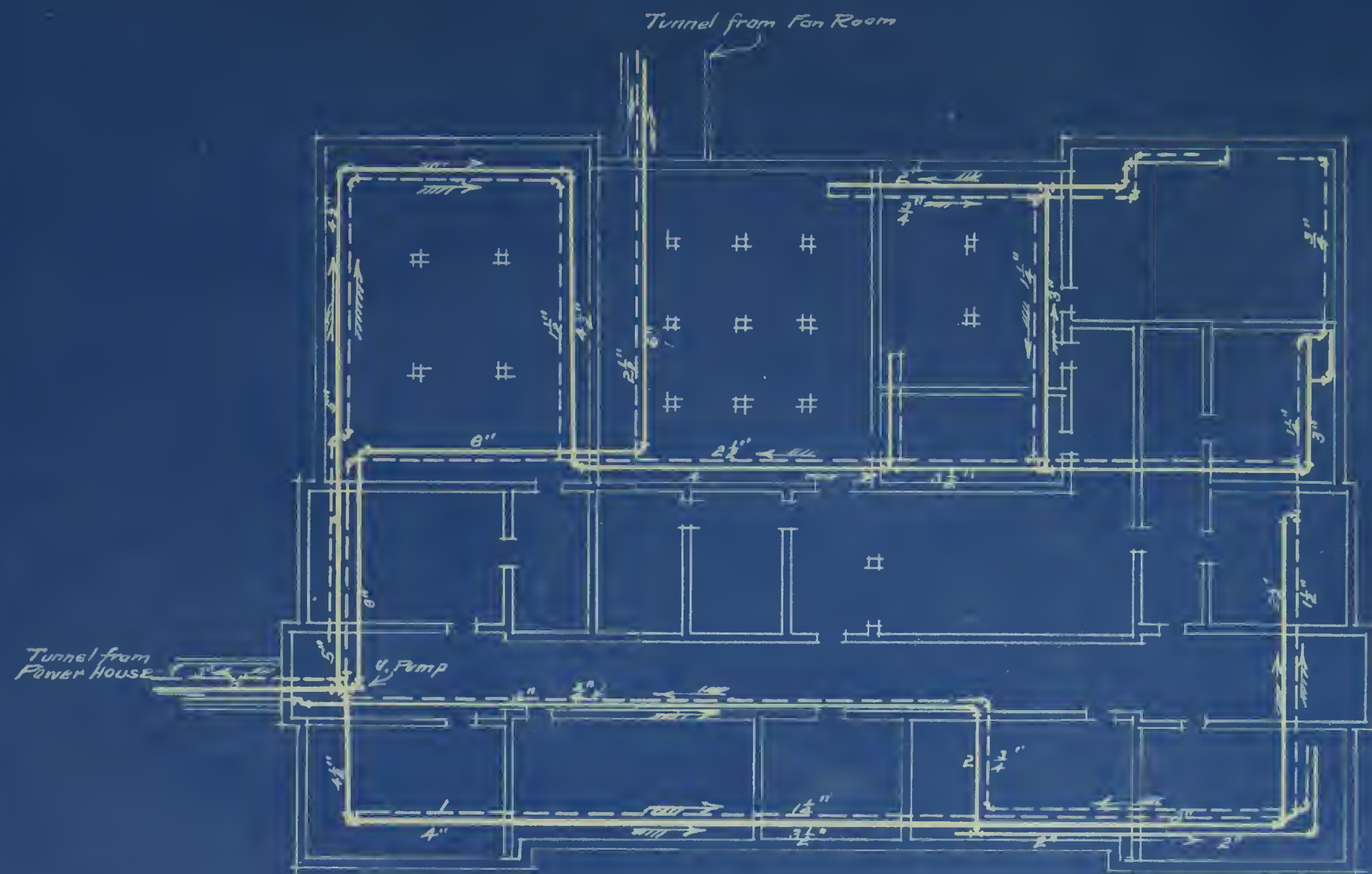
FOURTH FLOOR PLAN

PHYSICS BUILDING

~ PHYSICS BUILDING. ~



LABORATORY OF PHYSICS
UNIVERSITY OF ILLINOIS
W. CARBYS ZIMMERMAN ARCHITECT
STEINWAY HALL CHICAGO



HEATING PLAN – PHYSICS BUILDING

H.W.C.

TEST NO. 1.

ENGINEERING BUILDING

CONDENSED STEAM

Began Jan. 19. 1910 8:00 A.M.

Time	Water Coll't in Lbs.	Temp. °F	Steam Pressure
8:16	686	213°F	7.8#/□"
8:22	358	214	8
8:33	690	215	8.3
8:40	651	213	7.6
8:48	454	216	7.0
8:50	456	214	7.1
9:08	636	218	–
9:15	417	215	6.1
9:29	614	216	5.5
9:35	341	215	5.5
9:44	612	214	6.1
9:54	344	215	6.1
9:59	607	219	6.0
10:04	344	217	6.0
10:16	620	218	6.5
10:19	337	217	–
10:27	573	223	8.5
10:33	344	219	8.5
10:44	606	222	8.5
10:49	327	219	6.3
11:01	607	215	6.2
11:05	332	213	6.2
11:15	608	214	6.1
11:23	345	216	7.3
11:32	601	220	8.5
11:40	319	215	8.4
11:47	625	214	6.0
11:53	339	216	6.0
12:09	965	216	6.8
12:28	935	219	8.0
12:42	963	218	6.8
12:59	943	218	7.1
1:34	1883	218	7.3
2:03	1878	216	7.5
2:39	1926	216	6.8
3:13	1895	217	6.2
3:48	1924	217	8.8
4:00 P.M.	559	216	7.2
Totals	27685.		
Average		216°F	7.3#/□"

J.W.B.

TEST NO. 1

TEMPERATURES IN ROOMS ENG'R BLD'G

Jan. 19, 1910

Time	Number of Rooms						Temp. of Outside Air.
	1st Floor			2nd Floor			
	109	Cor.	112	211	Cor	214	
8:30 AM	74°F	–	72°F	76°F	70°F	74°F	28°F
9:30	68	–	73	79	72	65	32
10:30	78	–	71	79	72	68	35
11:30	78	–	70	81	72	69	37
12:30	80	–	74	83	73	73	44
1:30	75	–	76	70	73	71	47
2:30	77	–	79	74	72	72	48
3:30	64	–	81	74	74	71	45
Average	74.3	–	74.5	78	72.3	70.4	39.8

General Average = 73.9 °F.

Time	No. of Room						Temp. of Outside Air.
	3rd Floor			4th Floor			
	308	319	309	405	424	408	
8:30	64°F	67°F	66°F	68°F	68°F	71°F	28°F
9:30	70	69	70	74	72	74	32
10:30	72	71	72	75	73	75	35
11:30	74	72	71	76	74	76	37
12:30	68	75	72	77	76	77	44
1:30	71	73	68	78	79	77	47
2:30	70	75	71	78	77	77	48
3:30	68	73	74	74	79	77	45
Average	69.6	72	70.5	75.6	74.8	75.5	39.8

General Average = 73°F

Average Temp. of all Rooms = 73.2°F

m.v.B.

TEST NO. 1
PHYSICS BUILDING
CONDENSED STEAM

Began Jan. 19. 1910 – 8:27 A.M.

Time	Water Coll't in Lbs	Temp. °F	Steam Pressure	Vacuum Reading
8:38	505.	205	3	2
8:52	514.	209	"	1
9:58	535.	185.	"	8
10:50	505.	193	"	5.
11:13	520	195	"	6
11:33	530.	195	"	6
12:05	400	199	"	4
12:17	505	202	"	4
12:50	503	198	"	4
1:20	510	204.	"	4
1:38	541	198	"	2
2:07	511	202	"	5
2:31	546	200	"	3
3:05	512	200	"	3
3:33	534	199	"	3
4:02	509	202	"	3
4:27	480.	198	"	3
Total	8660			
Average		200.7	3	3.9
	Moisture in steam .015			

TEST NO. 1.

Temperatures in Rooms - Physics Bld'g. - Jan. 19. 1910.

1st Floor.

Time	No. of Room					Temp. of Outside Air.
	108.	112	100 A	Cor.	115.	
9:00	74°F	74°F	68°F	70°F	66°F	28°F.
10:00	72°	70	69	73	72.5	32
11:00	71	69	68	72	72.	35
12:00	71	69	70	73	70	36
1:00	71	69	–	73	70	38
2:00	71	70	–	70	69	43
3:00	72	70	66.	71	68	46
4:00	74	69	66.	71	68	48 45
Average	72	70	67.8	71.6	69.5	39.8

General Average = 70.2°F

2nd Floor.

Time	No. of Room.					Temp. of Outside Air.
	208	212	Cor.	205A	213	
9:00	77°F	76°F	76°F	79°F	73°F	28°F
10:00	73	72	75	78	72	32
11:00	73	72	74	78	72	36
12:00	74	71	75	77	72	38
1:00	75	71	75	76	71	43
2:00	75	70	75	76	71	46
3:00	72	72	76	76	71	48
4:00	74.	70	76	74	71	45
Average.	72	71.8	75.3	76.8	71.6	39.8

General Average = 73.5°F

Average Temp. for Both Floor = 71.6°F.

M.W.L.

TEST NO. 1.

TEMPERATURES IN ROOM PHYS. BLD'G.

Jan. 19, 1910.

3rd Floor

Temp.	No. of Room.					Temp of Outside Air.
	310	312	301	305	311	
9:10	75°F	74°F	76°F	79°F	76°F	28°F
10:10	72	70	75	76	74	32
11:10	71	70	75	76	73	36
12:10	72	70	75	76	72	38
1:10	72	69	75	76	72	43
2:10	72	69	74	75	72	46
3:10	72	70	75	75	72	48
4:10	72	70	74	74	72	45
Average	72.3	72	75	76	72	39.8

General Average = 73.2°F

4th Floor

Time	No. of Room.					Temp. of Outside Air.
	405A	401	412	406	—	
9:10	66°F	74°F	73°F	75°F	—	28°F
10:10	67°F	71	71	70	—	32
11:10	68°F	70	70	67	—	36
12:10	64	70	70	68	—	38
1:10	70	71	70	66	—	43
2:10	71	71	71	74	—	46
3:10	71	71	71	73	—	48
4:10	70	72	71	73	—	45
Average.	69	71.3	70.9	70.8	—	39.8

General Average = 70.3°F

Average Temp. for Both Floors = 71.5°F.

Average " " All " = 71.6°F.

mwb.

TEST NO. 2.

PHYSICS BUILDING

CONDENSED STEAM

Began Feb. 12. 1910, 10:33. A.M.

Time	Water Coll. in Lbs.	Temp °F	Steam Pressure	Vacuum Reading
10:58	550	190	3	6
11:23	510	"	"	"
11:42	517	"	"	"
12:00	515	"	"	"
12:15	505	175	"	"
12:25	505	190	"	"
12:40	582	186	"	"
12:55	502	188	"	"
1:24	571	192	"	5
1:45	504	187	"	6
2:07	550	197	"	5
2:26	523	196	"	"
2:44	558	195	"	"
2:57	515	187	"	6
3:17	556	195	"	"
3:34	503	189	"	"
3:54	592	190	"	5
4:08	508	192	"	6
4:29	557	192	"	5
4:49	523	"	"	"
5:09	595	"	"	"
5:21	535	"	"	"
5:33	376	"	"	"
Total	12427		"	
Average		192.8	3	5.5

Moisture in steam % = 2.7 approx.

mwb.

TEST NO. 2.

TEMPERATURES IN ROOMS – PHYS. BUILDING

Feb. 12, 1910.

1st Floor.

Time	No. of Rooms					Temp. of Outside Air.
	108	112	Cor.	107	115	
11:30	70°F	70°F	68°F	70°F	70°F	17°F
1:35	70	70	70	70	69	22
2:25	68	70	69	70	70	22
3:25	69	70	70	70	71	21
4:20	70	70	69	70	70	22
5:20	68	70	69	71	71	20
Average	69.2	70	69.2	70.2	70.2	20.6

General Average = 69.7°F.

2rd Floor

Time	No of Room.					Temp. of Outside Air.
	211	203	Cor.	208	212	
11:30	69°F	70°F	71°F	72°F	71°F	17°F
1:35	70	72	73	72	71	22
2:25	70	72	72	71	70	22
3:25	68	71	71	74	70	21
4:20	70	72	70	71	72	22
5:20	69	71	70	74	71	20
Average	69.3	71.5	71.2	72.3	70.8	20.6

General Average = 70°F

Average Temp. of both Floors = 69.8°F

M.B.

TEST NO. 2.

TEMPERATURES IN ROOMS
PHYSICS BUILDING
Feb, 12. 1910.

3rd Floor

Time	No. of Room.					Temp. of Outside Air.
	310	312	302	305	309	
11:30	72°F	70°F	73°F	71°F	72	17°F
1:35	72	71	74	71	72	22
2:25	72	70	72	70	72	22
3:25	73	72	72	69	72	21
4:20	72	70	71	70	72	22
5:20	72	72	71	70	72	20
Average	72.2	70.8	72.2	70.2	72	20.6

General Average = 71.5°F

4th Floor

Time	No. of Room					Temp. of Outside Air.
	405A	401	400A	406	—	
11:30	68°F	67°F	72°F	69°F	—	17°F
1:35	70	67	72	69	—	22
2:25	70	68	72	70	—	22
3:25	68	67	71	70	—	21
4:20	68	68	72	70	—	22
5:20	68	68	72	68	—	20
Average	67.5	67.5	71.8	69.4	—	20.6

General Average = 69.°F

Average Temp of all Floors = 70°F.

M.W.B.

TEST NO. 2.

ENG'R BUIDING

-CONDENSED STEAM-

Began Feb. 12, 1910 - 10:25 A.M.

Time	Wt. Coll't in Lbs.	Temperature	Steam Pressure.
10:48 AM	1124	225 °F	7.8 #/□"
10:56	574	219	8.0
11:03	556	222	8.1
11:16	886	215	8.1
11:26	568	222	6.3
11:40	792	214	7.0
11:50	600	216	8.3
12:04	940	218	6.3
12:14	600	223	6.8
12:30	974	214	7.0
12:39	599	219	7.5
12:55	965	216	8.5
1:05	600	220	8.5
1:19	967	218	8.5
1:29	587	222	8.5
1:45	950	215	8.6
1:55	603	222	6.1
2:09	957	216	8.5
2:18	605	222	8.5
2:35	953	216	8.0
2:43	598	218	7.8
3:00	946	215	6.0
3:09	598	221	8.0
3:25	950	217	8.2
3:30	602	219	8.7
3:50	945	217	8.6
4:00	600	219	8.5
4:15	939	217	8.8
4:24	608.5	218	6.7
4:41	925.5	216	6.8
4:52	596.5	217	6.7
5:06	942.	215	6.5
5:15	606	216	6.5
5:25	573	215	6.7
Total	25829.5		
Average		218.1 °F	7.6 #/□"

W.W.B.

TEST NO. 2.

- ENG'R. BUILDING -

TEMPERATURES IN ROOMS

Feb. 12. 1910.

Time	No. of Rooms						Temp. of Outside Air.
	1st Floor			2nd Floor			
	105	Cor.	112	214	Cor	211	
11:00	83°F	75°F	69½°F	65°F	70°F	62°F	17°F
1:00	84½	77	71	64	71	61	22
2:00	85	76	73	68	72	63	22
3:00	85	77	73	68	71	61	21
4:00	84	77½	73	68	71	61	22
5:00	84	77	73	67	71	61½	20
Average	84.3	76.6	72.1	66.7	71	61.6	20.6

General Average = 72.°F

Time	No. of Rooms						Temp. of Outside Air.
	3rd Floor			4th Floor			
	309	319	308	408	424	407	
11:00	73½°F	63°F	63°F	69°F	73°F	76°F	17°F
1:00	75	62	65	70	73	70	22
2:00	79	62	63	72	73	72	22
3:00	79	63	65	72	73	69	21
4:00	75	62	65	72	74	70	22
5:00	75	62	65	72	73	71	20
Average	76.1	62.3	64.3	71.2	73.2	71.3	20.6

General Average = 69.8°F

Average Temp. of all Floors = 70.9°F

O.M.G.

TEST. NO. 3.
- PHYS. BUILDING -
- CONDENSED STEAM -

Began. Feb. 18, 1910. – 9:28 A.M.

Time	Wt. of Water Collected in Lbs.	Temp. °F	Steam Pressure.	Vacuum Reading.
9:40	570	200	$2\frac{1}{2}$ Lbs.	5"
9:50	575	205	3	3
10:09	1215	206	"	$1\frac{1}{2}$
10:17	623	200	"	$4\frac{1}{2}$
10:38	1243	205	"	2
10:49	630	206	"	2
10:57	633	200	"	5
11:18	1253	204	"	4
11:26	622	192	"	$4\frac{1}{2}$
11:35	598	–	"	5
11:45	630	195	"	4
11:65	604	205	"	3
11:05	613	204	"	$3\frac{1}{2}$
12:14	612	198	"	5
12:22	610	195	"	5
12:30	630	198	"	"
12:51	1228	199	"	"
12:57	600	191	"	6
1:10	610	197	"	5
1:30	1214	196.5	"	"
1:43	632	195.	"	6
1:52	590	196.	"	$4\frac{1}{2}$
2:00	600	190	$4\frac{1}{2}$	$2\frac{1}{2}$
2:13	586	203	3	5
2:24	620	196	"	$4\frac{1}{2}$
2:37	606	200	"	5
2:46	637	196	"	"
2:58	605	199	"	"
3:07	620	196	"	$4\frac{1}{2}$
3:17	609	198	"	4
3:27	631	196	"	5
3:39	594	–	"	4
3:47	625	200	"	$4\frac{1}{2}$
3:57	577	190	"	4
4:04	616	178	$2\frac{1}{2}$	5
4:18	627	183	"	"
4:28	630	189	2	4
4:31	123	–	"	"
Total	26489.			
Average			3. #/□"	4.2"

n.w.b.

TEST. NO. 3.

TEMPERATURES IN ROOMS

— PHYS. BLD'G —

Feb. 18, 1910.

1st Floor.

Time	No. of Room					Temp. of Outside Air.
	108	112	100	119	115	
10:00 AM	71°F	72°F	72°F	72°F	70°F	6°F
11:00	72	72	73	71	71	11
1:00	72	72	75	71	71	15
2:00	72	72	74	70	70	18
3:00	72	72	75	71	71	20
4:25	70	72	75	70	69	15
Average	71.5	72	74	70.8	70.3	17 x

General Average = 71.7°F.

2nd Floor.

Time	No. of Rooms					Temp. of Outside Air.
	211	205A	COR.	208	212	
10:00 AM	70°F	75°F	72°F	73°F	72°F	6°F
11:00	70	74	73	75	72	11
1:00	70	73	72	74	72	15
2:00	70	74	72	73	72	18
3:00	70	73	72	72	72	20
4:25	70	71	71	74	71	15
Average	70	73.3	72	73.5	71.8	17

General Average = 72.1°F

Average Temperature of both Floors = 71.9°F.

mcf.

TEST NO. 3.

TEMP. IN ROOMS – PHYS. BLD'G

Feb. 18, 1910.

3rd Floor

Time	Number of Room					Temp of Outside Air.
	310	312	304	305	Cor.	
10:30	74°F	70°F	74°F	72°F	69°F	7°F
11:30	73	70	75	72	70	12
1:30	73	70	76	73	69	18
2:30	72	70	76	73	69	20
3:30	73	73	75	72	69	17
4:30	72	70	74	70	69	15
Average	72.8	70.8	75	72	69.2	

General Average = 72°F.

4th Floor

Time	Room No.					Temp. of Outside Air.
	406	400A	401	405	—	
10:30	71°F	72°F	68°F	68°F	—	7°F
11:30	70	72	68	68	—	12
1:30	70	72	69	70	—	18
2:30	70	72	69	71	—	20
3:30	70	72	68	70	—	17
4:30	70	72	68	69	—	15
Average	70	72	68.3	69.3	—	17

General Average = 70°F
Average of all Floors = 71.4°F

Place	Time						
	10:00 AM	11:00	12:00	1:00	2:00	3:00	4:00
Temp Room.	62°F	62°F	61°F	62°F	62°F	61°F	62°F
Air in Duct.	70°F	70	69	70	70	70	69

mwB

DATA FROM TEST NO. 4.

PHYSICS BUILDING

Began – Jan. 18, 1910 9:46 A.M.

Time	Wt. Co'l't in Lbs	Temp. °F	Steam Pressure Lbs/□"	Vacuum Reading
10:01	380.25	200	3	–
10:16	437.	—	"	–
10:29	474.	200	"	–
10:41	350	"	"	–
10:53	455	"	"	–
11:03	385	200	"	–
11:20	448.5	204	"	–
11:31	456.	202	"	–
11:43	435	204	"	4
11:55	626.	205	"	–
12:13	417	202	"	–
12:34	476	201	"	2
12:51	500	201	"	4
1:07	526	203	"	3
1:27	401	205	"	–
1:49	464	199	"	4
2:04	405	200	"	2.5
2:22	480	202	"	3.5
2:47	452.5	204	"	2.
3:13	540.	200	"	3
3:30	585	204	"	4
3:48	512	199	"	"
4:08	476	195	"	3
4:24	452	199	"	"
4:40	463	201	"	2
5:01	640	196	"	3
Total	12146.25			
Average		201.°F	3#/□"	3.1"

mw.

TEST NO. 4.

TEMPERATURES IN ROOMS - PHYS. BDL'G.

Jan. 18, 1910.

1st Floor

Time	Number of Rooms					Temp of Outside Air
	108	112	100A	Cor.	115	
10:50	70°F	69°F	69°F	70°F	69°F	30°F
12:15	71	69	68	70	68	33.2
1:35	71	69	67	70	70	36.
2:35	70	70	66	70	69	34.
3:35	70	70	66	70	68	32.
4:35	68	70	66	70	69	31
Average	70	69.5	67	70	68.8	32.7

General Average = 67°F

2nd Floor

Time	No. of Rooms					Temp. of Outside Air
	208	212	Cor.	205 A.	213	
10:50	72°F	69°F	73.°F	71°F	71°F	30°F
12:15	71	70	74.	72	71	33.2
1:35	71	70	76.	71	71	36
2:35	71	70	74.	71	71	34
3:35	72	70	74.	71	70	32
4:35	69	69	73.	70	69	31
Average	71	69.7	74.	71	70.5	32.7

General Average = 71.2°F

Average of both Floors = 69.1

M.W.O.

TEST NO.4.

TEMPERATURES IN ROOMS - PHYS. BLD'G.

Jan. 18, 1910.

Time	No of Room					Temp of Ext. Air
	310	312	301	305	311	
	3rd Floor					
11:10	70°F	68°F	72°F	72°F	70°F	30°F
12:25	"	67	72	72	70	33.2
1:45	"	67	72	71	70	36
2:45	"	67	72	71	70	34
3:45	69	69	72	70	70	32
4:45	69	69	71	71	70	31
Average	70.4	68	71.8	71.2	70	32.7

General Average = 70.2°F.

4th Floor

Time	No of Rooms					Temp of Ext. Air.
	405A	401	412	406	-	
11:10	67°F	68°F	70°F	70°F	-	30°F
12:25	68	69	70	72	-	33.2
1:45	69	69	70	68	-	36.0
2:45	69	69	70	71	-	34.0
3:45	68	69	70	72	-	32.0
4:45	68	69	71	73	-	31.0
Average	68.2	68.8	70.2	70.7	-	32.7

General Average = 69.5°F

Average of all Floors = 70.2°F.

mwb.

TEST NO. 5

Test on Piping System in Physics Building

Began. Feb. 18, 1910. 7:30 PM.

Time	Wt. of Water Collected	Temp. °F.	Steam Pressure #/□"	Vacuum Reading
7:30				
8:27	580#	170	3	7"
9:12	610	170	3	7
9:30	170	172	3	7
Total	1360			
Average		170.7	3	7

m.b.

TABLE NO. 1

Engineering Building 1st Floor.

Room.	Size of Room	Cu. Cont	Exp. Wall	Exp. Glass	Net Wall	Expos.	Rad. in Rm
112	19'-0"X14'-0"X11'-8"	3100	163 Sq.ft.	58.5 □'	104.5 □'	W.	76.5□'
112 A	19'-0"X20'-0"X11'-8"	4430	455	117.0	338.0	N.W.	120.
114	20'-0"X35'-0"X11'-8"	8160	443	117.0	326.0	N.E.	153.3
108	19'-0"X21'-0"X11'-8"	4650	466	117.0	349.0	S.W.	96.7
106	20'-0"X21'-0"X11'-8"	4900	268	58.0	209.5	S.	56.7
104	20'-0X16'-0"X11'-8"	3730	233	66.0	167.0	S.	43.3
116	9'-0"X16'-0"X11'-8"	1680	105	22.0	830.0	N.	100.0
102	27'-0"X22'-0"X11'-8"	6930	350	66.0	284.0	S.	76.7
100	12'-0"X12'-0"X11'-8"	1680	0	0.	0.	—	—
124	27'-0"X14'-0"X11'-8"	4410	478	110.0	368.0	N.W.	110.0
122	27'-0"X21'-0"X11'-8"	6610	245	88.0	157.0	W.	66.7
120	27'-0"X24'-0"X11'-8"	7550	280	110.0	170.0	S.W.	107.3
118	16'-0"X15'-0"X11'-8"	2800	175	44.0	131.0	W.	36.7
123	27'-0"X14'-0"X11-8"	4410	478	110.0	368.0	N.E.	102.7
118 A	16'-0"X16'-0"X11'-8"	2980	0	0	0	—	—
121	27'-0"X46'-0"X11'-8"	18100	530	198.0	332.0	E.	150.0
117	16'-0"X15'-0"X11'-8"	2800	175	44.0	131.0	E.	36.7
115	26'-0"X16'-0"X11'-8"	4850	60	22.0	38.0	N.	23.3
101	27'-0"X22'-0"X11'-8"	9700	350	66.0	284.0	S.	83.3
103	20'-0"X16'-0"X11'-8"	3735	233	66.0	167.0	S.	43.3
105	40'-0"X21'-0"X11'-8"	9800	740	176.0	564.0	S.E.	150.0
114 A	6'-0"X24'-0"X11'-8"	1680	233	66.0	167.0	N.	26.7
113	6'-0"X24'-0"X11'-8"	1680.	233	66.0	167.0	N.	23.3
111	19'-0"X35'-0"X11'-8"	7750	443	117.0	326.0	N.W.	43.3
109	20'-0"X35'-0"X11'-8"	3870	620	176.0	444.0	N.E.	166.7
E. & W. Cor.	200'-0"X13'-0"X11-8"	2600	302	133.0	169.0	E. & W.	} 590.9
N. & S. Cor.	98'-0"X11'-0"X11'-8"	1078	126	70.0	58.0	N. & S.	
	Totals—	135663	8186	2284.0	5902.0		2369.9

TABLE NO. 2
ENGINEERING BUILDING 2rd FLOOR

Room	Size of Room	Cu. Cont.	Exp. Wall	Exp. Glass	Net Wall.	Exp.	Rad. in Rm.
214	40'-0"X35'-0"	20500 Cu.ft.	1350. Sq.ft.	475. Sq.ft.	875. Sq.ft.	N.E.&W.	328.4 Sq.ft.
210	14'-0"X13'-0"	2660	190	95.	95	W	72.
208	26'-0"X21'-0"	8000.	690	237.8	452.2	S.W.	151.9
206	13'-0"X21'-0"	4000.	190	47.5	142.5	S	60.9
204	20'-0"X17'-0"	5000	293	117.	176.	S	78.6
202	26'-0"X22'-0"	8380	440	117.	323.	S	104.1
201	26'-0X22'-0"	8380	440	117.	323	S	104.1
203	20'-0"X17'-0"	5000	293	117.	176	S	78.6
205	40'-0"X21'-0"	12300	880	285.3	594.7	S.E.	197.6
207	28'-0"X13'-0"	5530	190	95.	95.	E.	56.7
211	40'-0"X35'-0"	20500	1350	475.	875.	N.E.W.	337.7
213	26'-0"X17'-0"	6490	117.	39.	78.	N.	45.3
Vault	17'-0"X16'-0"	4000	0	0	0.	—	0
216	8'-0"X16'-0"	1880	117.	39	78.	N.	45.3
218	16'-0"X14'-0"	3280	205.	58.5	146.5	W	62.3
220	20'-0"X61'-0"	17900	1190	390.	800.	N.S.W.	373.8
219	27'-0"X15'-0"	5950	220	58.5	161.5	E.S.	105.6
217	16'-0"X14'-0"	3280	205	58.5	146.5	E.	45.3
221	48'-0"X45'-0"	31700	1360	468.	892	N.E.	120.
N.&S. Cor.	50'-0"X11'-0"	8060	821	176.	821.	—	355.
E.&W. Cor.	150'-0"X13'-0"	28600	586	234.	352	N.	
	Totals---	211390	111270	3703.0	7424.0		2746.5

Ceiling Height = 14'-8"

TABLE NO. 3.

Engineering Building - 3rd Floor

Room	Size of Room	Cu. Con't	Exp. Wall	Exp. Glass	Net Wall	Exp.	Rad. in Room.
314	40'-0" X 35'-0"	20500 Cu.Ft.	1350 Sq.Ft.	410. Sq.Ft.	940. Sq.Ft.	N.E.W.	284.4.
310	14'-0" X 13'-0"	2660	190	82	108	W.	84.2
308	26'-0" X 21'-0"	8000	690	205	485	S.W.	149.3
304	20'-0" X 17'-0"	5000	293	117.	176	S.	75.3
302	26'-0" X 23'-0"	8750	454.	108	346	S	110.8
301	13'-0" X 23'-0"	4380	190	54	136	S	55.3
300	26'-0" X 23'-0"	8750	454	108	346	S	110.8
303	20'-0" X 17'-0"	5000	293	117	176	S	75.3
305	40'-0" X 21'-0"	12300	880	246	634	S.E.	227.3
307	29'-0" X 13'-0"	5530	190	82	108	E	50.9
309	40'-0" X 35'-0"	20500	1350	410	940	N.E.W.	101.6
313	26'-0" X 17'-0"	6490	117.	39	78	N	45.3
316	10'-0" X 17'-0"	2490	146	39	107	N	160.
318	17'-0" X 32'-0"	7975	205	54	151	W.	73.6
317	17'-0" X 16'-0"	3987	205	54	151	E	48.1
319	68'-0" X 61'-0"	60800	2820	825	1995	N.E.W.	546.2
306	13'-0" X 21'-0"	4000	190	41.	149	S	50.9
N.&S. Cor.	157'-0" X 13'-0"	30000	0	0	0	—	} 295.0
E.&W. Cor.	33'-0" X 12'-0"	5800	0	0	0	—	
	Total	222912	102810	2991.0	7290.0		2859.9

Ceiling Height = 14'-8"

TABLE NO. 4.
Engineering Building 4th Floor.

Room	Size of Room	Cu. Cont.	Wall Sur.	Exp. Glass	Net Wall	Rad in Rm
408	40'-0" X 42'-0	21820 Cu Ft.	1065 Sq Ft.	32. Sq Ft.	1033 Sq Ft.	144. Sq Ft.
406	40'-0" X 28'-0"	14550.	885.	32.	853.	84
404	20'-0" X 13'-0"	2300.	160.	16.	144.	32.
402	17'-0" X 22'-0"	5600.	300.	19.	281.	60.
400	31'-0" X 22'-0"	10200.	465.	57.	408.	112.
401	31'-0" X 22'-0"	5600.	300.	19.	281.	56.
403	20'-0" X 13'-0"	2300.	160.	16.	144.	32.
405	40'-0" X 28'-0"	14550	885.	32.	853.	104.
407	40'-0" X 42'-0"	21820.	1065.	32.	1033.	148.
411	19'-0" X 17'-0"	4340.	150.	19	131.	24
418	17'-0" X 32'-0"	8150.	210.	19.	191.	44.
416	9'-0" X 16'-0"	2160.	150.	19.	131	—
425	12'-0" X 16'-0"	2880.	180.	19	161.	28.
424	27'-0" X 24'-0"	9700.	765.	76	689.	96.
422	27'-0" X 20'-0"	8100.	300.	38.	262.	80.
420	27'-0" X 16'-0"	6470.	240.	38.	202.	80.
423	27'-0" X 24'-0"	9700.	765.	76.	689.	96.
421	27'-0" X 37'-0"	15000.	540.	76.	464.	144.
417	17'-0" X 16'-0"	4750.	210	19.	191.	36.
415	6'-0" X 17'-0	1530.	0	0	0	0
E & W. Cor.	112'-0" X 13'-0"	24100.	320	32	288.	64.
N & S. Cor.	80'-0" X 11'-0"	13200.	0	0	0	0
	Totals	208145.	9115.	686.	8429.	1464.

Sum of Totals of Each Floor

Floor	Cu. Conts.	Glass Sur.	Net Wall	Radiation
1st	135663 Cu Ft.	2284 Sq Ft.	6902 Sq Ft.	2369.9 Sq Ft.
2rd	211390.	3703.	7424.	2746.5
3rd	222912.	2991.	7290.	2859.9
4th	208145.	1698.	8429.	1464.0
Total	778110	10676.	29045.	9441.0

Sq Ft. of HP. = 1568.0

Total = 10999.0 Sq Ft.

awb.

TABLE NO. 5.

Physics Building - 1st Floor.

Room	Size of Room.	Cu. Cont	Exp. Wall	Exp. Glass	Net Wall.	Exp	Rad in ft.
112	44'-0"X58'-4"	35820 Cu.ft.	144	378.2 □'	10558 Sq.ft.	N.W.	420.
112 A	12'-0"X23'-4"	3915	0	0	0	—	0
112 B	14'-4"X 11'-6"	2310	0	0	0	—	0
114	14'-4"X 11'-0"	2210	0	0	0	—	0
110	13'-5"X22'-11"	4300	189.	40.75	148.25	W.	50
1A	8'-8"X22'-6"	2680	119.	40.75	78.25	"	40
108	22'-1"X22'-1"	6830	618	163.0	455.0	S.W.	130
106	10'-10"X22'-1"	3340	152	40.75	111.25	S.	40
104	20'-0"X19'-9"	5540	280	75.60	204.40	S.	80
102	18'-6"X19'-9"	5110	259	75.60	183.40	"	80
116	15'-0"X22'-8"	4760	0	0.	0	—	0
100	45'-9"X55'-0"	45400	824	56.0	768.0	N	102
119	29'-7"X38'-9"	20600	532	56.0	476.	"	72
121	17'-9"X 11'-9"	2920	0	0	0	—	0
100A	15'-3"X29'-7"	8100	0	0	0	—	0
125	10'-0"X23'-2"	3240	0	0	0	—	0
123	35'-3"X23'-4"	11500	0	0	0	—	0
101	18'-6"X19'-9"	5120	259	75.60	183.40	S	80
103	19'-11"X19'-9"	5500	280	75.60	204.40	"	80
105	10'-10"X22'-1"	3360	152	40.75	111.25	"	40
107	22'-1"X22'-1"	6830	618	163.0	455.0	S.E.	130
1B	8'-6"X22'-6"	2680	119	40.75	78.25	E	40
109	13'-5"X22'-1"	4150	189	40.75	148.25	"	40
111	13'-3"X19'-7"	3620	185	37.82	147.18	"	50
113	14'-4"X19'-7"	3930	201	75.60	125.40	"	60
115	31'-6"X28'-11"	12750	844	257.0	587.0	N.E.	200
117	12'-4"X28'-11"	5000	174	37.8	136.20	N	58.5
E.Vest.	8'-0"X14'-0"	1570	196	72.50	123.5	E	168.
W. "	8'-0"X14'-0"	1570	196	72.50	123.5	W	168
S. "	6'-6"X24'-7"	2240	344			S.	168.
M.Cor.	159'-0"X12'-0"	26800	0	0	0	—	368.
Cor.(2)	24'-6"X10'-0"	3430	0	0	0	—	0
" (3)	24'-6"X10'-0"	3430	0	0	0	—	0
" (4)	66'-0"X10'-0"	9250	0	0	0	—	0
M.Shop	25'-6"X51'-10"	24000	2400	410.0	1990.0	N.E.S.	331.
E.Room	24'-0"X25'-6"	5350	665	115.0	550.0	N.W.S.	
T.Room	24'-0X25'-6"	6580.	792				2995.50
Total— — - - -		305735.0	12020.0	2441.34	10578.6		

TABLE NO. 6.

Physics Building 2nd Floor.

Room	Size of Room	Cu. Con't	Exp. Wall	Exp. Glass	Net Wall.	Exp.	Rad. in Rm.
212	44'-0" X 58'-8"	36200 Cu.ft.	1847. Sq.ft.	567.5 Sq.ft.	1280.5 Sq.ft.	N.W.	450. Sq.ft.
214	12'-0" X 13'-9"	2300	0	0.	0	—	0
216	23'-3" X 85'-0"	27700	446.	220.0	226.0	N drop 1 low	240.0
212B	12'-4" X 9'-0"	1552	0	0.	0	Wt	0
210	13'-3" X 22'-11"	4250	187.	40.75	148.25	"	60.0
2A	8'-10" X 24'-4"	3000	124	40.75	83.25	S.W.	40.0
208	22'-1" X 22'-5"	6650	610	163.0	447.0	S	130.0
206	11'-0" X 22'-5"	3460	154	40.75	113.25	"	40.0
204	20'-1" X 19'-9"	5550	281	81.75	199.5	"	80.0
202	18'-10" X 19'-9"	5200	278	81.5	196.5	"	80.0
201	27'-3" X 19'-9"	7540	382	122.0	260.0	" drop 2 low	80.0
203	11'-4" X 19'-9"	3130	159	40.75	118.25	S.W.	40.0
205	18'-4" X 15'-9"	4050	257	81.5	175.5	E	80.0
205A	14'-11½" X 22'-5"	4700	210	122.0	88.0	"	90.0
2B	8'-10" X 24'-4"	3000	124	40.75	83.25	"	40.0
207	13'-5" X 22'-1"	4150	189	40.75	148.25	"	50.0
209	13'-7" X 19'-7"	3720	190	40.75	149.25	N.E.	50.0
211	14'-8" X 19'-7"	4010	187	81.5	105.5	N.W.	56.7
213	31'-6" X 28'-11"	12720	855	245.0	610.0	E	237.5
215	12'-1" X 28'-11"	4900	370	221.0	249.0	—	138.5
217	11'-11" X 21'-4"	3560	300	53.6	246.4	E.W.N	50.0
219	6'-0" X 12'-0"	1010	0	0	0	E	0
Cor A.	180'-4" X 12'-6"	31600	535	280.0	255.0	—	200.0
Cor B	68'-6" X 10'-4"	9940	46	26.8	19.0	—	30.0
Cor C	24'-6" X 10'-2"	3490	0	0	0	—	0.
	Total	197392.	7733.0	2532.15	5200.85		2262.7

Ceiling Height = 14'-0."

gmb

TABLE NO. 7.

Physics Building 3rd Floor.

Room.	Size of Room.	Cu. Cont. Cu. Ft.	Exp. Wall Sq. Ft.	Exp. Glass Sq. Ft.	Net Wall Sq. Ft.	Exp.	Rad. in Room.
312	44'-0" X 73'-6"	45700.	2450.	694.0	1756	E.N.W.	630.0
3A	8'-10" X 22'-6"	2780	123	40.75	82.25	W	40.0
3C	12'-0" X 9'-6"	1615	0	0	0.	—	0.
310	22'-1" X 22'-5"	6650	610	163.0	226.0	S.E.	130.0
308	11'-0" X 22'-5"	3460	154	40.75	113.25	S	40.0
306	20'-1" X 19'-9"	5550	281	81.5	199.5	"	80.0
304	18'-10" X 19'-9"	5200	278	81.5	196.5	"	80.0
314	23'-3" X 85'-0"	27700	446	220.0	226.0	"	240.0
302	23'-11" X 19'-9"	6622	278	122.0	156.0	"	100.0
301	18'-10" X 19'-9"	5200	278	81.5	196.5	"	80.0
303	20'-1" X 19'-9"	5550	281	81.5	199.5	"	80.0
305	33'-6" X 22'-5"	10500	768	203.75	564.25	S.E.	170.0
3B	8'-10" X 24'-4"	3000	124	40.75	83.25	E	40.0
307	13'-5" X 22'-1"	4150	189	40.75	148.25	"	50.0
309	13'-7" X 19'-7"	3720	190	40.75	149.25	"	50.0
311	14'-8" X 19'-7"	4010	187	81.5	105.5	"	60.0
313	31'-6" X 28'-11"	12720	855	245.0	610.0	N.E.	237.5
315	12'-1" X 28'-11"	4900	575	163.0	412.0	N.W.	138.5
317	11'-11" X 21'-4"	3560	300	81.5	218.0	W.	50.0
319	6'-0" X 12'-0"	1010	0	0.	0	—	0.
Cor. A	179'-0" X 12'-6"	31300	176	150.75	25.25	E.W.	120.0
Cor. B	68'-6" X 10'-4"	9940	46	26.8	19.20	E	30.0
Cor. C	9'-10" X 10'-2"	1400	0	0	0	—	0.
	Total	2062.3.7	8589.0	2681.05	5908.0		2446.0

Ceiling Height = 14'-0"

TABLE NO. 8.

Physics Building, Attic Floor

Ceiling Height Varies

Room	Size of Room	Cu. Con't	Exp. Wall.	Exp. Glass	Net Wall.	Roof Surface	Rad. in Room.
408	39'-2"X77'-7"	35000 Cu.Ft.	532 Sq.Ft.	484. Sq'	480 □'	3875 □'	525. □'
406	33'-6"X22'-5"	8000	504	117.	387	–	123.6.
402	39'-4"X19'-9"	7200	80.	14.	66	480.	93.3
404	952 □' Floor	9520	50.	14.	36	432.	100.
400A	54'-0"X12'-0"	6500	0	0.	0	–	0.
401	39'-0"X19'-9"	7200	80	14.	66.	480.	93.
403	33'-6"X22'-5"	8000	504	117.	387.	–	123.6
400	22'-0"X14'-0"	3080	126	48.	78.	–	50.0
405A	44'-6"X58'-7"	21500	334.	432.	334.	–	439.3
407	35'-0"X23'-0"	7500	48	14.	34.	–	93.3
412	27'-0"X23'-0"	9300	400.	361.8	38.2	420.	150.
404A	33'-0"X14'-0"	4620	126.	48.6	77.4	–	50.
410	23'-0"X23'-0"	4770	46.	14.	32.	–	53.3
405	32'-6"X23'-0"	8000	198.	52	146.	2925.	49.
Totals		140190	3028.0 8612	1731.4	2160.6	8612.	1943.7
			11640.0		9909.6		

Sum Total of Each Floor.

Floor	Cu. Con't	Glass Sur.	Net Wall	Radiation.
1st	305735 cu.'	2441.3	10578.6	2995.5
2nd	197392.	2532.1	5200.0	2262.7
3rd	206237.	2681.0	5908.0	2446.0
4th	140190.	1731.4	9909.0	1943.7
Total	849554	9386.	31585.6	9648.0 Add Piping

ENG'R BUILDING

Radiation in Rooms 1st Floor

Room	Number of Rad.	Type	Height (Inches)	Number of Col.	Number of Sect.	Surface Sq. Ft.
105	2		32"	2	25	83.3
105	1		"	"	20	66.7
109	3	"	"	"	50	166.7
111	1	"	"	"	13	43.3
103	1	"	"	"	13	43.3
103	1	"	"	"	25	83.3
Cor.	5	"	45	"	118	590.0
102	1	"	32	"	23	76.7
116	1	"	"	"	3	10.0
106	1	"	"	"	17	56.7
114	3	"	"	"	46	153.3
112	1	?	26	—	17	76.5
112	1	"	32	2	36	120.0
108	2	"	"	"	29	96.7
104	1	"	"	"	13	43.3
113	1	"	"	"	7	23.3
118	1	"	"	"	11	36.7
117	1	"	"	"	11	36.7
119	2	"	"	"	45	150.0
120	1	"	"	"	13	43.3
120	1	"	38	"	16	64.0
122	2	"	32	"	20	66.7
124	2	"	"	"	33	110.0
123	1	"	38	"	9	36.0
123	1	"	32	"	20	66.7
Jan'r	1	"	"	"	8	26.7
					Total	2369.9□'

CNM.

[illegible] [illegible]

[illegible]

ENG'R BUILDING.

Radiation in Room. 2rd Floor.

Room	Number of Rad.	Type	Height. Inches	Number of Col.	Number of Sect.	Surface Sq. Ft.
211	4	Pipe	—	4	84	237.7
"	2	Ideal	32	2	30	100.0
207	1	"	32	2	17	56.7
205	3	Pipe	—	4	51	144.3
"	1	Ideal	32	2	16	53.3
Cor.	3	"	45	"	71	355.0
203	1	"	32	"	10	33.3
"	"	Pipe	—	4	16	45.3
201	"	"	—	"	25	70.8
"	"	Ideal	32	2	10	33.3
213	"	Pipe	—	4	16	45.3
218	"	"	—	"	22	62.3
"	"	"	—	3	10	33.3
217	"	"	—	4	16	45.3
"	1	Ideal	38	2	8	32.0
219	"	Pipe	—	4	26	73.6
220	"	"	—	"	26	73.6
"	"	Ideal	32	2	10	33.3
"	2	Pipe	—	4	53	150.0
"	1	Ideal	32	2	13	43.3
"	"	Pipe	—	4	26	73.6
221	"	Ideal	38	2	30	120.0
216	"	Pipe	—	4	16	45.3
202	"	"	—	"	25	70.8
"	"	Ideal	32	2	10	33.3
204	"	Pipe	—	4	16	45.3
"	"	Ideal	32	2	10	33.3
214	4	Pipe	—	4	76	215.1
"	2	Ideal	32	2	34	113.3
210	1	"	38	"	18	72.0
208	2	Pipe	—	4	36	101.9
"	1	Ideal	32	2	15	50.0
206	"	Pipe	—	4	18	32.0
						Total --2746.5□'

nwb.

ENG'R BUILDING

Radiation in Rooms 3rd Floor.

Room	Number of Rad.	Type	Height Inches	Number of Col.	Number of Sect.	Surface Sq. Ft.
314	4	Pipe	—	4	78	220.7
"	2	Ideal	38"	2	26	104.0
"	1	"	32	"	16	53.3
310	1	Pipe	—	4	18	50.9
"	1	Ideal	32	2	10	33.3
308	1	"	"	"	"	"
"	2	Pipe	—	4	41	116.0
306	1	"	—	"	18	50.9
"	1	"	—	"	16	45.3
304	1	Ideal	32	2	9	30.0
"	1	"	"	"	12	40.0
302	1	Pipe	—	4	25	70.8
300	1	Ideal	32	2	12	40.0
"	1	Pipe	—	4	25	70.8
301	1	Ideal	32	2	16	53.3
318	1	Pipe	—	4	26	73.6
317	1	"	—	"	17	48.1
319	8	"	—	"	193	546.2
"	2	Ideal	32	2	48	160.0
313	1	Pipe	—	4	16	45.3
303	1	"	—	"	"	45.3
"	1	Ideal	32	2	9	30.0
305	3	Pipe	—	4	65	184.0
"	1	Ideal	32	2	13	43.3
307	1	Pipe	—	4	18	50.9
309	4	"	—	"	88	249.0
"	1	Ideal	32	2	23	76.7
Cor.	3	"	45	"	59	295.0
					Total---	2859.9□'

amb.

ENGINEERING BLD'G.

Radiation in Room-4th Floor.

Room	Number of Rad.	Type	Height Inches	Number of Col'm	Number of Sect's	Surface Sq. Ft.
408	2	Ideal	38"	2	36	144.
406	"	"	"	"	21	84
404	8	"	"	"	8	32
402	1	"	"	"	15	60
400	2	"	"	.	28	112
401	1	"	"	"	14	56
Toilet	"	"	"	"	6	24
403	"	"	"	"	8	32
405	2	"	"	"	26	104
407	"	"	"	"	37	148
418	1	"	"	"	11	44
417	"	"	"	"	9	36
420	"	"	"	"	20	80
422	"	"	"	"	20	80
421	2	"	"	"	36	144
423	"	"	"	"	24	96
425	1	"	"	"	7	28
424	2	"	"	"	24	96
Cor.	1	"	"	"	16	64
					Total----	1464.

mwb

PHYSICS BLD'G

Radiation in Rooms 1st Floor.

Room	Number of Rad.	Type	Height Inches	Number of Colum's	Number of Sect.	Surface Sq Ft.
108	2	Peerless	32	2	39	130
W. Cor.	1	"	38	"	25	100
W. Vest	2	"	"	"	42	168
1A	1	"	32	"	12	40
110	"	"	"	"	15	50
112	4	"	40	3	84	420
106	1	"	32	2	12	40
104	2	"	"	"	24	80
102	"	"	"	"	"	80
C. Cor	"	"	38	"	42	168
C. Vest	"	"	"	"	"	168
100	1	"	47	3	17	102
119	"	"	37	1	24	72
101	2	"	32	2	"	80
103	"	"	"	"	"	80
105	1	"	"	"	12	40
107	2	"	"	"	39	130
E. Cor	1	"	38	"	25	100
E. Vest.	2	"	"	"	42	168
1B.	1	"	32	"	12	40
109.	"	"	"	"	15	40
111	"	"	"	"	15	50
113	"	"	"	"	18	60
115	3	"	"	"	60	200.
117	1	"	"	4	9	58.5
					Total	2995.5

NOTE:

This table does not include coils around skylight.

PHYSICS BUILDING.

Radiation in Room. 2nd Floor.

Room.	Number of Rad.	Type.	Height in Inches	Number of Col.	Number of Sect.	Surface Sq. Ft.
E. Cor.	1	Peerless	32	2	18	60
205A	2	"	"	"	27	90
205B	2	"	"	"	24	80
203	1	"	"	"	12	40
2B	"	"	"	"	12	40
207	"	"	"	"	15	50
217	"	"	"	"	"	50
209	"	"	"	"	"	50
211	"	"	"	"	17	56.7
213	"	"	"	4	15	97.5
"	"	"	"	2	42	140.
215	"	"	"	4	9	58.5
"	"	"	"	2	24	80.
N.E. Cor.	"	"	"	"	9	30.
Lib.	2	"	"	"	24	80.
C. Cor.	"	"	"	"	"	80.
202	"	"	"	"	"	80.
204	"	"	"	"	"	80.
206	1	"	"	"	12	40.
208	2	"	"	"	39	130.
W Cor	1	"	"	"	18	60.
2A	"	"	"	"	12	40.
210	"	"	"	"	18	60.
212	4	"	"	3	100	450.
216	6	"	"	"	72	240.
					Total----	2262.7

H.W.B.

PHYSICS BUILDING.

Radiation in Rooms – 3rd Floor.

Room	Number of Rad.	Type	Height Inches	Number of Col.	Number of Sect.	Surface Sq. Ft.
W. Cor.	1	Peerless	32"	2	18	60
310	2	"	"	"	39	130
308	1	"	"	"	12	40
3A	1	"	"	"	12	40
312	6	"	"	3	140	630
314	6	"	"	2	72	240
306	2	"	"	"	24	80
304	2	"	"	"	24	80
302	2	"	"	"	30	100
301	2	"	"	"	24	80
303	2	"	"	"	24	80
305	3	"	"	"	51	170
E. Cor.	1	"	"	"	18	60
2B	"	"	"	"	12	40
307	"	"	"	"	15	50
317	"	"	"	"	15	50
309	"	"	"	"	15	50
311	"	"	"	"	18	60
315	"	"	"	4	9	58.5
315	"	"	"	2	24	80.
313	"	"	"	4	15	97.5
313	2	"	"	2	42	140
N.W. Cor.	1	"	"	"	9	30
					Total--- -	2446.0

mof.

PHYSICS BLD'G

Radiation in Rooms 4th Floor.

Room	Number of Rad.	Type	Height Inches.	Number of Col.	Number of Sect.	Surface Sq Ft.
S.E. Cor.	1	Peerless	32"	2	15	50.0
403	3	"	24	"	53	123.6
405	1	"	"	"	21	49.0
405A	6	"	32	"	58	193.3
401	2	"	"	"	28	93.3
407	2	"	"	"	28	93.3
404	3	"	"	"	30	100.0
412	2	"	"	"	30	100.0
412 A	2	"	"	"	16	53.3
402	2	"	"	"	28	93.3
408	1	"	"	"	69	230.0
406	3	"	24	"	53	123.6
W. Cor.	1	"	32	"	15	50.0
408	1	"	24	"	21	49.0
					Total	1401.7

Sk'lt Coils 542.0
Total 1943.7□'

Total Rad. on all Floors = 2664.5
331.0 Coils - 1st Fl.
2262.7
2446.0
1943.7
9647.9 Sq. Ft.

G.W.C.

TABLE SHOWING SOME RESULTS OF EXPERIMENTS MADE BY EXPERIMENT STATION, UNIVERSITY OF ILLINOIS.

AVERAGE B.t.u. TRANSMITTED PER HOUR PER SQUARE FOOT RADIATOR SURFACE PER DEGREE DIFFERENCE BETWEEN TEMPERATURE OF STEAM AND ROOM, FOR RADIATORS OF DIFFERENT HEIGHTS.

Height of Radiator	Test Number	Ave.B.t.u.Trans per hr. per sq. ft.per ° dif'T.	Number of Columns
32"	11,12,13,14,15,16,17,26,27	1.60	2
38	23,24,25	1.56	"
41	1,2,3,~~4,5~~,6,7,8,9,	1.66	"
41	6,7,8,9,	1.59	"
45	18,19,20,22,	1.45	"
32,38,41,45	All of the above	1.58	"

mdb